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THE SUGAR CANE:

A Monthly Magazine,

DEVOTED TO THE INTERESTS OF THE SUGAR CANE INDUSTRY.

VOLUME VI.

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THE SUGAR CANE.

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NOTES ON THE HISTORY OF THE SUGAR INDUSTRY OF THE HAWAIIAN ISLANDS.

By Thomas G. Thrum.

No. I.

Sugar cane is indigenous to the Hawaiian Islands, as it is to all the principal groups of islands in the Pacific; and it was noted by Cook, in his visit to these islands, as being "of large size and of good quality." The natives, however, made no use of it beyond that of food, and it was not until the settlement of foreigners that any attempt was made to utilize the vast fields of wild cane that natives say grew in every valley and plain.

The kind of cane common to the soil is the white cane, somewhat resembling the Tahiti variety, being, when under a good state of cultivation, of a pale greenish-yellow colour—deepening on the latter shade as it matures—rather soft rim, long-jointed, with the eye or bud partly sunken in the stalk; tassels freely and ratoons well in most localities. There are several other varieties now cultivated, of which I will make mention at another time.*

(*Note by the Editor. "The Tahitian sugar cane *(Aheo)* is celebrated as the most productive cane in the West India Islands. I noticed eight varieties on the Island, as follows:—

1. Rutu..... A cane of good quality.
2. Avae..... A cane of indifferent quality.
3. Irimotu .. A rich cane, but not growing to a large size.

There are many localities laying claim to the first mill, and as many claiming the credit for the establishment of this industry, which has long since been the leading one, that it has been no easy task to define its legitimate founder. After examination through all the early publications of the islands for definite authority and a starting point, the only information thereon is found in a paper read by the late L. L. Torbert before the Royal Hawaiian Agricultural Society, in January, 1852, wherein he states that "the earliest sugar manufacture was in 1802, by a Chinaman, on the island of Lanai, who came here in one of the vessels trading for sandalwood, bringing with him a stone mill and boilers, and after grinding off one small crop and making it into sugar, went back the next year with his apparatus." Mr. Torbert gave as his authority John White, who arrived at the islands in 1789, and who, from his constant travel back and forth in the retinue of the chiefs, had ample opportunity to learn of the time and place of the new industry.

The fact of Mr. T. giving credence to the above, and his presenting the same before the Agricultural Society, is proof sufficient in the minds of many that the same is correct; yet there are a large number who place no reliance on the statement, and look to a later period for its establishment.

As before stated, various localities lay claim to the first established mill, or, more properly, the first manufacturing of sugar, for sugar and molasses were produced before the establishment of a mill.

Don Paulo Marin recorded in his journal of making sugar in Honolulu in February, 1819; but no other allusion is made

4. Patu A good cane of a red colour.
5. To-ura .. A dark striped cane, hard and good.
6. To-ute. ... A bad cane of a reddish colour.
7. Veu..... A good cane.
8. Vaihi This attains a large size and is considered of the best quality. The last variety is said by the natives, to have been introduced from the Sandwich Islands, which is a curious circumstance if correct, as it has been long celebrated in the West Indies for the rich syrup it produces."—*Bennett's Naturalist in Australasia.*)

thereto. Sugar was made in Honolulu about 1823, by Lavinia, an Italian, who had the cane pounded or mashed on huge wooden trays (poi boards) by natives with stone-beaters, collecting the juice and boiling it in a small copper kettle. About this same time Antone Catalina is also claimed by some to have been the founder of the industry by making excellent syrup at Waikapu, Mani—the site of the present Waikapu mill—and Hungtai, a Chinaman, is said to have established the first mill at Wailuku.

Various accounts agree as to the manufacture of sugar and molasses being entered into quite generally about this time (1823-4), though doubtless with the view of rum making, which was then carried on extensively. In 1828, Governor Boki, with Stephen Reynolds and three others interested, had one crop of sugar taken off his plantation in Manoa Valley, but after one cutting it wasted away for want of care.

That the various sugar mills at this time were but small and primitive, and the cultivation of cane but little attended to, may be inferred from there being no notice made thereof, and on this account, perhaps, our historian Jarves did not touch upon this subject in his history of the Islands, though he had ample means in his day (1840) of learning the full facts of its origin and growth.

In view of the foregoing facts, we must, without doubt, give credit to Messrs Ladd and Co. for the *bona fide* establishment of sugar manufacture, who, in 1835, secured a grant of land at Koloa, Kanai, from the Government, for silk and sugar culture. This seems to have been the first systematic sugar plantation, and was under the charge of a Mr. Hooper, who broke up the land with a light plough drawn by natives. Their first mill must have been a rude island-made one, doubtless, as mention is made of an iron one having arrived in 1837, but was not in operation in November.

The year following (March, 1838) note is made of Koloa producing 5,039 lbs. sugar and 400 gals. molasses from one acre of plant cane. No mention is made of the number of boilings.

The early history of this first plantation shows it to have been one of severe struggle, for previous to 1840 two mill sites were

abandoned, and the entire works, including buildings, machinery, and furnaces were sacrificed. In 1841 the third mill was erected, which, with improved works, enabled it to increase its produce, though the quality of sugar at, and up to this time was very inferior, until the arrival of M. Prevost, who, having had considerable experience in sugar manufacture in the Isle of Bourbon, was engaged at this plantation, and by his superior method of treatment of the juice, greatly improved the quality of the sugars that the value in consequence was much enhanced.

Notwithstanding the difficulties under which this plantation was working, and the prophecies of many for its failure, it gave an impetus to others in various parts of the islands, for in 1838 there were in operation, and about to be erected, twenty mills by animal power and two by water power.

The first notice made of any exportation is for the year 1837, when 4,286 lbs. sugar and 2,700 gals. molasses were exported. A regular table from this point would be valuable and interesting, but as this was prior to the establishment of Customs' regulations at these islands, the figures we have for data are from merchants' published statements, and are not complete, as there are no figures at all for 1842, hence my compilation from 1843. (Already published in the November number).

Up to this time (1843) Hawaiian sugars did not enjoy a favourable reputation abroad, partly from the low grades, but more from the injudicious desire of many producers to realise all possible. They shipped sugars imperfectly cured, and in several cases added thereto all the refuse that could be collected from the drying houses; nor was our reputation thoroughly established for good merchantable sugars until after the establishment of the Royal Hawaiian Agricultural Society in 1851, when their attention was called to the fact, and their influence sought thereon.

(To be continued.)

ECONOMY OF FUEL.

(*Continued from page 452.*)

CHAPTER SECOND.

STUDY OF THE LOSS OF HEAT UNDERGONE IN ORDINARY FIRING.

SECTION IV.

I am now about to study, in a general manner, the mode which they have of utilising the carbon in industrial combustion of fuel, and, in particular, in steam boilers. I will deduce from this what are the inherent losses of weight in this manner of procedure. We will see what remedies have been hitherto proposed. I will establish their insufficiency, and, in fine, the necessity of substituting gas heating, such as I understand it, for all the systems hitherto employed.

The industrial employment of fuel is too often founded on false principles, or to speak more correctly, on a total absence of principles. All industrial heating apparatus rests, with very rare exceptions, on the employment of the natural draft produced by a chimney, and what follows will show, I hope, that *the chimney, properly so called, is the plague of industry.*

Let us take, then, as a type our ordinary fire-place, adapted for the heating of a distillery boiler, for example. Let us see what are the losses of heat fatally sustained in this case. These are:—

1st. Loss resulting from the heat carried off by the *excess of air* that the employment of a grate necessitates.

2nd. Loss resulting from the employment, correctly speaking, of the chimney.

3rd. Loss due to the *want of smoke consumption.*

4th. Loss resulting from the formation of cinders.

5th. Loss of heat employed to vaporise about 48 kilos. of water per 100 kilos. of burnt coal.

6th. Loss due to the radiation from the bottom of the fire-place and the walls of the furnace or of the boiler.

Section V.

1. Loss Resulting from the Heat Carried off by the Excess of Air Required by the Employment of a Grate.

In grouping by species the combustible parts of the coal adopted, I find :—

Carbon—total	82·39143	kilos.
Hydrogen ,, ...	4·73462	,,
Sulphur ,, ...	0·18824	,,
	87·31429	kilos.

The total quantity of oxygen necessary to transform completely these combustibles into CO_2, HO, SO_2 is given, by calculation, as equal to 257·77568 kils. In withdrawing from it the 1·48571 kils. of oxygen existing in the illuminating gas we have 256·28997 kils. corresponding to a weight of air equal to 1114·30422 kils., occupying at 0 and 760 a volume equal to 861·797 c.m.

Now, the employment of the grate with a natural draft does not allow this quanity of air theoretically necessary for combustion to be given. The grate obstructs it, consequently the air cannot circulate freely in the ignited mass, and to be able to feed the fire one is obliged, in practice, greatly to increase the width of the passage and the speed of the air. The principal authors admit, in principle, that it is necessary to calculate the furnace in such a manner as to be able to introduce regularly double the air required. And in spite of that, combustion remains imperfect.

The temperature of the burnt gases escaping at the bottom of a chimney is very changeable ; there are cases in metallurgic industry where it is much over 500° ; on the contrary, for steam generators, this figure forms too high an average, I will accept it provisionally as a mean for all industrial furnaces.*

* Quite recent personal experiences on the utilisation of locomotive machines, which I will shortly publish, have led me, as the result of very exact thermometric observations, to admit that the temperature of the gases at their entrance into the smoke box—that is to say, at the point where their usual effect ceases, is comprised between 450° and 500,° which justifies the industrial mean allowed, if we consider that the railways waste a quantity of carbon considerable in relation to the general consumption of the country.

This quantity is considerable. This is only an average, for it will clearly be variable, according to the temperature of escape, the quantity of air unburnt, and, in fine, the specific heat adopted. In puddling furnaces, where often torrents of air pass in excess, it will reach an enormous value. The same thing occurs, at particular moments, in the progress of express locomotives. At any rate, we may conclude *that it is of the last importance to prevent this introduction of too much air.*

SECTION VI.

2. LOSS RESULTING FROM THE EMPLOYMENT, CORRECTLY SPEAKING, OF THE CHIMNEY.

Certain authors confine themselves to saying the draft by the chimneys cost 25 per cent. of the heat furnished by the combustion of the coal. This number can be settled in a more exact manner. The loss due to the natural draft is evidently caused by the heat carried by the products of combustion.

Now, I have previously adopted a mean temperature of 500° for these smokes at the bottom of the chimney.

In supposing—which is to place myself in an unfavourable position, from the point of view of my argument—that the combustion may be complete and without excess of air, the calculation applied to the numbers formerly adopted gives the following composition for the burnt gases :—

Nitrogen in the burnt air	858·01425
Carbonic acid of combustion	302·10191
,, from the illuminating gases ..	0·70000
Water from combustion	42·61158
Hygroscopic water	5·00000
Ammonia from illuminating gas	0·50000
Sulphurous acid from combustion	0·37648
	1209·30422

In adopting as formerly the specific heats at 0°—and I will show further on that this hypothesis is unfavourable to my reasoning—the specific heat equivalent of this gas forms a total equal to :

288·25532.

In supposing for these burnt gases at the moment of their exit a mean temperature of 500°, the total heat carried off by them amounts to 144127·66 units of heat—

say a loss equal to .. $\frac{144127 \cdot 66}{803779.6} = 18$ per cent.

I insist upon showing here that this number is far from being a maximum, for several reasons.

For first, I have taken into consideration the value of the specific heats corresponding to the temperature of 0°. Now what follows will show that the specific heats of the burnt gases which are freely expanded are very distinctly greater than these admitted values, and this will be theoretically and experimentally established. It is thus in effect that M. Regnault has found for acid CO_2, 0·187 at 0° and at 200, 0·2396. The specific heat of other gases, and, above all, that of the vapour of water, ought to be distinctly increased also.

In the second place, I have allowed a complete combustion. Now we are far from this. The smokes contain a proportion, often considerable, of carburetted hydrogen, of carbonic oxide, and even of free hydrogen, of which the calorific power is much superior to that of air, of acid CO_2, and of nitrogen.

In conclusion, it is of enormous importance to deprive the burnt gases of their heat as completely as possible, and not to introduce an excess of air.

SECTION VII.

3. LOSS DUE TO THE WANT OF SMOKE CONSUMPTION.

The question raised here has been for a number of years the subject of sharp discussions. Many inventions are produced. None until now has given entirely satisfactory results. That comes above all from the fact that inventors have only considered the question from a one-sided and narrow point of view, without going to the foundation. Some, apart from the question of health, attribute no economic importance to this study. Others, on the contrary, have exaggerated this importance, but without seeing

in what this study necessarily attached itself to the general problem of the economy of fuel.

I have recapitulated above the various conditions of a proper combustion, but not one of the apparatus hitherto employed realises them all.

As to the system generally adopted, and which I here study, one may say it satisfies none of them.

Indeed the fuel, the coal, and the means of combustion, the air, *are never intimately mixed, and cannot be so—they are not of the same physical nature.*

We are obliged on that account alone to introduce a great excess of air. The fifth condition is, then, far from being satisfied.

As to the third and the fourth they are often only fulfilled by chance. The locomotive tubular generators are, from this point of view, under very bad conditions.

From this incomplete combustion it results that the *chimney smokes.*

Now the smoke produces two principal annoyances. I will not stop at the first, caused by the unhealthiness and inconvenience that its presence brings. The second attacks industry more directly, for it is summed up in a loss of money; and without saying what the minimum is, it is almost always considerable, and often attains incredible proportions.

Whoever has seen the smoke from metalworks, coke furnaces, glass furnaces, &c., ought to be convinced of what I here bring forward.

The smoke, besides, may be colourless, so to say, and include large proportions of combustible gases; for that which colours it of a more or less intense black is not the carbon carried off from the furnace, but the impalpable carbon produced by the partial decomposition of the hydrocarbons in proportion as the smoke cools.

There is not a moment of the combustion when the proportion of the mingling of air and of gas may be suitable; at each second the loss by excess of air is combined and added to that arising from imperfect mingling, and produces the most deplorable effects, from an economical point of view.

Various analyses have been attempted by different *savants* in order to determine the proportions of combustible gases remaining in the smokes.

Besides the difficulty presented by these analyses, and which renders them more or less incorrect, it is impossible to draw a fair conclusion from such a variety of figures as those presented by these several analyses.

Those of M. Debette assert an average loss of 9 per cent. The first of these analyses furnishes on the contrary figures for 24 per cent.

Experiments made in Alsace give a mean of 15 per cent.

Ebelmen formerly only found a loss of 7 per cent.

In fine, M. Ser, in an attempt with the smoke consumer Thierry has found a loss of 40 per cent.

If I observe that these numbers are arrived at from experiments made on steam boilers, that in other very important branches of industry, above cited, the production of smoke is far greater than in this special case, it will be understood that I consider I have taken a very restricted limit in adopting as the average loss due to this cause 20 per cent.

SECTION VIII.

4. LOSS RESULTING FROM THE FORMATION OF CINDERS.

This loss is itself very variable. In locomotives, for example, notwithstanding the narrow space between the bars, it is yet very important, since they do not collect the cinders.

In metal furnaces it reaches often considerable proportions. They poke the fire often, and consequently they cause many coals to fall which have not been burnt into coke, and which continuing to be burnt under the grate, cause that intense radiation from the puddling and remelting furnaces.

In experiments made at Cherbourg on steam boilers, MM. Tresca and Silbermann have found cinder products equal to 25 per cent. of the coal used. I believe myself still to be in a minimum limit in taking as a mean loss 15 per cent.

SECTION IX.

5. LOSS OF HEAT EMPLOYED TO VAPORISE 48LBS OF WATER.

In calculating the theoretic power of the coal taken, I have adopted as the calorific power of the hydrogen the number, 34,462, but the vaporising of the water created by its combustion absorbs a certain quantity of heat.

In order to calculate it, I ought clearly to take, as the value of the latent heat of the vaporisation of water, the number 606·5; for if this latent heat is low at the moment of combustion, it rapidly increases at the expense of the sensible heat of the surrounding gases, and the true loss due to this cause will have as an element the value of that latent heat at the temperature of the atmosphere, or rather at 0°, to be received into the valuation before accepted.

This heat of vaporisation is here completely lost; it is found equal to:

$$48 \times 606{\cdot}5 = 29{,}112 \text{ units of heat, or } 3{\cdot}6 \text{ per cent.}$$

SECTION X.

6. LOSS DUE TO RADIATION AND TO THE FUSION OF THE CINDERS.

I will not fix provisionally on a figure for these last losses, comparatively of slight importance, and very changeable. That would be to again place myself here in a hypothesis unfavourable to my argument.

If now I recapitulate the various losses before calculated I find:—

1st.	Loss due to excess of air	16 per cent.
2nd.	Loss due to the special use of the chimney	18 ,,
3rd.	Loss due to want of smoke consumption ..	20 ,,
4th.	Loss due to making cinders	15 ,,
5th.	Loss due to vaporising 48 kilos. of water	3·6 ,,
6th.	Loss due to radiation	memorandum.
		72·6

Say a total of 73 per cent. as the average loss of heat sustained in a furnace with a grate and a natural draft.

Yet once more. This number is only a general average; there

are cases where it is surpassed, others where it is not reached. But in all metal industry this number constitutes a minimum.

If we apply this value to steam boilers, we find as the production of dry vapour 3·3 kil. per kilog. of coal. This number is very low; but if we consider that there are often cases where the steam produced contains as much as 40 per cent. of water carried off not vaporised, we understand that in many cases it unhappily expresses the truth.

I will add here that, in the case of evaporation, even this number is far from being reached.

THE FERTILIZATION OF FARM LANDS.

BY C. A. GOESSMANN, PH.D.

One of the most important features of the present day in the management of the farm is the general and extensive use of commercial concentrated fertilizers. Their merits are so well established that a rational and thorough system of agriculture is thought impracticable without their assistance, particularly when it is proposed to apply them in connection with stable manure.

It is but thirty years since the mineral constituents of plants were looked upon as being merely of incidental occurrence, and without any essential bearing upon their development, but these views have been entirely changed in the progress of science. Numerous and more exact chemical analyses of the ashes of plants, which accumulated during the beginning of the present century, began then to engage the attention of scientific investigators. In comparing the ash constituents of different plants, they soon noticed that certain mineral elements were present in a more or less conspicuous proportion in every plant, and the general occurrence of these substances led ultimately to the quite natural assumption that their presence might be necessary for the performance of some physiological process of vegetable life. Actual experiments, instituted under well-defined circumstances for the purpose of testing this view, proved quite conclusively that a

certain kind and a certain amount of mineral elements are indispensable for the complete development of a plant, and that, in case its own ash-constituents are not supplied, the plant may come to blooming, yet it will not produce a perfect seed. To Professor Justus von Liebig, before all others, belongs the merit of pointing out these important relations. It cannot be without historical interest, at least, to recall here the fact that even the use of guano was urged by him in 1840, on the strength of his analytical results, and its virtues explained by reference to its constituents, while as yet not one pound of it had been used upon the farms of Europe.

Alexander von Humboldt's report, in 1814, concerning the existence of the guano beds upon the Chincha Islands, and the use of that substance as a fertilizer by the Peruvians, had passed by unnoticed. In citing this instance it is unnecessary to mention that I am fully aware of the well-authenticated statements that the dung of fowls was highly valued many centuries ago by the ancient Romans, and that wood ashes, bones, gypsum, lime, marl, &c., were used more or less effectively in agricultural industry previous to the period referred to above. Yet it will be conceded that their essential relations to plant life, as we understand them at present, were then unknown.

The successful introduction of mineral fertilizers for agricultural purposes is one of the striking illustrations of the influence and the value which exact modes of inquiry, with well-defined questions, have over mere experimenting, without a previous correct appreciation of the agencies and the principles involved in the operation. True, progress in agriculture can in almost every instance be proved to be the result of the application of such rational modes of investigation as every branch of natural and physical science has sanctioned in its own field of inquiry. To begin with, an analysis has proved to be here, as elsewhere in experimental science, the safest and most economical course to secure a desirable foundation for synthetical attempts. The recent improvements in general farm-management do not consist in the introduction of any particular new system; since to keep up the fertility of the soil by fallow and the rotation of crops, to use irrigation and drainage

to enrich one portion of the farm lands at the expense of another, by keeping a certain proportion of meadow-lands to secure manure for the grain-lands,* or to fertilize the surface-soil at the expense of the sub-soil, either by subsoiling or by cultivating deep-rooting plants—as lupine, esparsette, lucerne, beet-roots, or red-clover, etc., for feeding purposes, and in the interest of fertilization—are all time-honoured modes of operation of more than one thousand years' standing. What we claim as the real progress is a more efficient, because intelligent use of their best features. The cause of their repeated failures in former ages was but a natural consequence of the state of general information, and mainly due to the want of suitable means for gaining a clear understanding of their respective methods of working. The intelligent farmer of the present day has greatly improved his chances by calling on the scientific investigators in every department of natural science to aid him in his varied and complicated field of labour. The best experimental resources of the present day have served of late as guides in drawing more correct deductions, and in arriving thus at more reliable results. To study the growth of our farm plants under simple and well-defined circumstances, in the greenhouse and upon the experimental field, and to control the results thus obtained carefully in their various relations by means of the balance in the chemical laboratory, have greatly facilitated the discovery of more correct interpretations of facts than is possible under more complicated circumstances in the usual course of general farm operations. Leaving the improvement of farm implements here out of consideration, we may safely assert that the main reasons of better

* 2,000 lbs. hay contain (Wolff) :—

Nitrogen	26·2	pounds.
Total ash	133·2	„
Potassa	34·2	„
Lime	15·4	„
Magnesia	6·6	„
Phosphoric acid	8·2	„
Sulphuric acid	6·8	„
Silicic acid	39·4	„

The relative proportion of phosphoric acid to potassa in the produce of the meadows is one of the former to four of the latter; in the case of grain-producing lands, one to one in wheat and one to two in Indian corn.

results in agricultural operations, wherever carried on in a rational way, is due to a better knowledge regarding the relations of vegetable life to the soil, to the air, and to water, and the various reactions of these agencies upon each other, with an appreciation of the mutual dependency of animals and plants in the business of farming. Modern agriculture recognizes as its basis the necessity of a quick restitution to the soil of those substances which the crops raised have abstracted. To prove the existence of these relations, and teach how to comply with the requirements in each particular case, is the work of scientific investigators of the present generation. There is no opposition to any particular system of farm management—each farmer is left to choose an agricultural industry best adapted to his natural and personal resources, yet all are restricted by one common rule: they have to comply with that unalterable relation which exist between demand and supply, since each plant, although in its own way, tends to exhaust the soil sooner or later.

The rapid and extensive introduction of the commercial mineral fertilizers is the best possible acknowledgment, although frequently unconsciously given, on the part of the practical farmer, regarding his belief in the usefulness of science in agriculture. The use of these concentrated fertilizers has fairly revolutionized this industry. They have proved, wherever judiciously applied, a most profitable investment. A new era may be dated from the day of their introduction, for the farmer finds his field of operations less restricted than formerly, and being more at liberty to choose his crops with reference to his markets, is able to make his avocation more remunerative. Their importance cannot be over estimated in regard to the maintenance of the fertility of our farm lands, particularly as long as farmers still allow a fair portion of their home fertilizing material to waste, and as long as the sewage question of our centres of social life remains practically unsolved. Their special character in many instances favors specific modes of action, and thus renders them indispensable for the production of special crops for manufacturing purposes.

In the following pages I propose to present, first a few considerations concerning fertilization with reference to the commercial fer-

tilizers in general use; and, secondly, a short sketch of the recently introduced Stassfurt potash and magnesia fertilizers. In connection with these topics I shall also state the results of an analytical examination of a number of commercial fertilizers in use among the farmers of the State.

Stable manure is still the main fertilizer in ordinary farm operations, yet its peculiar value rests to-day more on its beneficial influence on the physical condition of the soil than on its effect on its chemical composition. A few analytical statements concerning the composition of stable manure under ordinary circumstances may give some idea of its usual chemical ingredients in various stages of disintegration.

One thousand pounds contained (Wolff):—

	Water.	Organic substances.	Ash (total).	Nitrogen.	Potassa.	Soda.	Lime.	Magnesia.	Phos. Acid.	Sulph. Acid.	Silicic Acid.	Chlorine.
When fresh	710	246	44·1	4·5	5·2	1·5	5·7	1·4	2·1	1·2	12·5	1·5
„ half decomposed	750	192	58·0	5·0	6·3	1·9	7·0	1·8	2·6	1·6	16·8	1·9
„ more decayed	790	145	65·0	5·8	5·0	1·3	8·8	1·8	3·0	1·3	17·0	1·6

Finding ourselves better informed concerning the requirements of a complete manure, we know that stable manure, although the most complex of our common fertilizers, can only in exceptional cases claim that title. As its composition depends mainly on the food consumed and the substance used as an absorber of the animal secretions, its commercial value varies widely, and the first cost depends on the price of the fodder consumed for its production. Wherever a farmer sells a portion of the produce of his industry, without replacing the ash-constituents of the articles sold, either in the form of food bought for his live-stock or its equivalent in the form of suitable fertilizers, he cannot prevent his stable manure, for his system of operations, becoming by degrees an inefficient fertilizer, for it does not contain all the essential elements in such a proportion as his crops for a full repetition require. A change in fertilizers is equal to a change in the composition of the soil,

particularly of that portion which alone is really valuable. The present condition of numerous farms in this and other countries is an unmistakable demonstration of this fact. The cultivation of meadow lands, fallow, rotation of crops, superior mechanical preparation of the soil, in fact, all those modes of treatment which aim at a suitable development of the latent natural resources of the soil, can at best only more or less delay the time of its agricultural exhaustion; they cannot prevent that ultimate result. To rely in high farming, as a general rule, on procuring a sufficient supply of mineral plant food from the natural disintegration of the soil, has proved to be unsafe. The commercial concentrated fertilizers, however, furnish excellent means to correct the composition of stable manure, obtained under any system of agricultural industry, and to make it a complete fertilizer for the crops under cultivation. The kind of fertilizer which a farmer ought to buy is best learned from the article he sells. A few analytical statements bearing on this question may convey some idea about the amount and the kind of plant food contained in 1,000 pounds of air-dried substance of some prominent articles of farm produce:—

	Nitrogen.	Total Ash.	Potassa.	Soda.	Lime.	Magnesia.	Phos. Acid.	Sulph. Acid.	Silicic Acid.
Wheat grain ..	20·8	17·7	5·5	0·6	0·6	2·2	8·2	0·4	0·3
Rye ,, ..	17·6	17·3	5·4	0·3	0·5	1·9	8·2	0·4	0·3
Barley ,, ..	15·2	21·8	4·8	0·6	0·5	1·8	7·2	0·5	5·9
Oat ,, ..	19·2	26·4	4·2	1·0	1·0	1·8	5·5	0·4	12·3
Corn ,, ..	16·0	12·3	3·3	0·2	0·3	1·8	5·5	0·1	0·3
Peas	35·8	24·2	9·8	0·9	1·2	1·9	8·8	0·8	0·2
Beans	40·8	29·6	12·0	0·2	1·5	2·0	11·6	1·5	0·4
Potatoes	3·2	9·4	5·6	0·1	0·2	0·4	1·8	0·6	0·2
Com. beetroots..	1·8	8·0	4·3	1·2	0·4	0·4	0·8	0·3	0·2
Turnips	1·8	7·5	3·0	0·8	0·8	0·3	1·0	1·1	0·2
Hay	13·1	66·6	17·1	4·7	7·7	3·3	4·1	3·4	3·4
Live calf	25·0	38·0	2·0	0·6	16·3	0·5	13·8	0·0	0·1
,, oxen	26·0	46·6	1·7	1·4	20·8	0·6	18·6	0·0	0·1
,, sheep	22·4	31·7	1·5	1·4	13·2	0·4	12·3	0·0	0·2
,, pig	20·0	21·6	1·8	0·2	9·2	0·4	8·8	0·0	0·0
Wool (washed)..	94·4	10·3	1·9	0·3	2·5	0·6	0·3	0·0	0·3
Milk.....	6·4	7·0	1·7	0·7	1·5	0·2	1·9	0·1	0·0
Cheese	45·3	67·4	2·5	26·6	6·9	0·3	11·5	0·0	0·0
Eggs.....	21·8	84·8	1·6	1·5	43·3	0·3	3·2	0·0	0·0

It must be quite obvious that information of the kind which these analyses convey may claim to be a safe guide when the question of restoring to the soil what has been abstracted comes under consideration. Upon large farms in Europe, it is quite customary to keep a book account of the movements of the plant food abstracted from the soil. The intelligent manager of a farm cannot fail to consider his prepared plant food on hand as the capital he puts at interest; on its fair return depends his pecuniary success. Money judiciously expended in commercial fertilizers is known to pay well, and to manure liberally pays better than to manure scantily. It is a well-known fact, that wherever commercial fertilizers have been freely used as additions to stable manure, the crops have been raised to twice what they were when only stable manure has been depended on. England, and many other countries of Europe, furnish the proof of this assertion. The farmer who wishes to benefit by the late rational progress in his occupation, ought to make himself somewhat familiar with the teachings of the previous analytical tables, and information of a similar character, for a disregard of this advice will surely leave him behind his more judicious neighbours. I call attention here to an observation which has been made quite generally in former times, as well as in the present generation, namely, that in the cultivation of grain crops with the exclusive use of stable-manure, first, the grain has failed, and then the straw; and, in the case of high manuring, that the yield of grain declined and that of the straw increased, until, finally, the entire crop failed to be remunerative. Wheat first showed this peculiar tendency, and other farm crops are affected more or less in the same manner. This singular fact has found its explanation in the influence which the universal practice of selling grain has on the soil employed for its production. A careful examination of the seeds of all our cereals has shown that they contain an immense proportion of phosphoric acid in comparison with the straw; for instance—

Wheat grain	0·82	per cent.	phosphoric acid.
Wheat straw	0·23	,,	,,
Indian corn	0·55	,,	,,
,, stalks and leaves	0·38	,,	,,

In selling the grain from two-thirds to four-fifths of the phosphoric acid abstracted from the soil is lost for the next crop, and so year after year. When now we consider that this acid is but slowly rendered soluble by natural agencies, the first result cannot be doubtful. The straw will find for some time still its sufficient supply of phosphoric acid, but not enough for the formation of the grain. Continual demand, without an adequate supply, directly or indirectly, means exhaustion, even in the more favoured localities. The general condition of most farm lands regarding their present reduced store of phosphoric acid alone accounts for the rapid and universal indorsement of phosphatic fertilizers—as bones, superphosphates, &c.—for it is contrary to the teachings of recent exact experimental inquiry to ascribe to phosphoric acid a particular virtue over any other of the essential articles of plant-food, as potassa, lime, magnesia, iron, sulphuric acid, carbonic acid, water, and some suitable nitrogen compound, as ammonia or nitric acid. Our information concerning the requirements for a full development of plants here becomes more concise. It has been proved by experiments that the above named substances are not only essential, but of equal importance, which means, that in case one of them is wanting the rest cannot act; for substitutions of elements take place only to a very limited degree. The exact position of other elements, as sodium, silicium, chlorine, &c., which are frequently found in plant ashes, is still less defined. Their functions, in case they have any in the vegetable economy, are still a matter of inquiry; but they are considered at present of secondary consequence. The observation, in practice, that of two crops which require the same essential soil-constituents, and in a similar obvious proportion, one fails where the other still yields a satisfactory return, does not necessarily contradict the previous statement. A close examination in all instances of this kind will show that these plants live either upon a quite different stratum of soil, or their roots are by nature more or less better fitted to absorb to a larger degree the available plant food, they either have more numerous fine rootlets, or their roots spread over a larger space. The rate of absorption by the roots depends on the surface they present to the

soil. We find it, therefore, quite natural that conditions of land exist where potatoes fail and beetroots prosper, and also the reverse; or that barley and oats will for years prosper where wheat has failed, although in both instances a similar amount of the essential articles of mineral plant-food are required. The examination of the construction and the extension of the roots of our farm plants has given most valuable suggestion in regard to a suitable system of rotation of crops.

The peculiar agricultural value of any fertilizer depends on the conditions of the soil under treatment, and that one of its constituents exerts the highest effect, which increases the amount of that ingredient which is most wanting in the soil for the support of the plants under cultivation. In some instances it may be a suitable nitrogen compound; in others phosphoric acid, or potassa, or lime, &c. The *agricultural* value of a fertilizer and its *commercial* value are measured by quite different standards; the former is determined by the judicious selection of the farmer, and the latter depends on the relation of demand and supply in the general market. The amount and the relative proportion of the active plant-food in the soil, control the yield of the crops, provided the weather is the same. To secure the highest possible yield, under given circumstances, requires manuring to such a degree that the plants find, at any given period of their growth, the largest amount of each article of plant-food they are capable of turning to account in their development. It is a noticeable fact that plants quite frequently require, even of the same article of plant-food, a different quantity in the various stages of their growth. It has been noticed, for instance, that the grain crops consume an unusually large proportion of nitrogen during the period of blooming and forming the seed. In case the supply is not adequate to the periodical demand of the plants, their yield must suffer. It is for this reason in particular that a liberal manuring of farm-lands, on rational principles, pays better than to furnish but a meagre supply.

(To be continued.)

TESTING SUGAR SOLUTIONS BY MEANS OF AREOMETERS AND THE OPTICAL SACCHAROMETER.

BY P. CASAMAJOR.

PART FIRST.

The analysis of sugar solutions by the optical saccharometer usually gives rise to one of the following problems :—

(1) To determine the quantity of pure sugar in the solution such as it is, or

(2) To determine the quantity of pure sugar in the solution, irrespective of the quantity of water in it; *i.e.*, the quantity of pure sugar in the substance as it would be if deprived of its water, or, more briefly, the quantity of sugar in the dry substance.

To ascertain the percentage of pure sugar in the solution such as it is, we must treat it as we would any other saccharine substance.

In the first place we must weigh 16·35 grs. of it, if it is to be treated in a Soleil-Duboscq saccharometer, or 26·048 grs. if we use a Ventzke Soleil instrument. The quantity, once weighed, is diluted with water so as to occupy 100 centimetres cubic, and, if necessary, decolorized and clarified. The result given by the saccharometer is the percentage of pure sugar in the solution.

If we wish to ascertain the quantity of pure sugar in the solution without having any regard for the water, we may use either of the following processes.

(*a*) We take the density of the solution with an areometer, to which density corresponds a certain percentage of impure sugar in solution. If the areometer used is one of Balling's, the quantity of sugar is given directly; if the scale is Beaumé's, or if it shows the specific gravities, we find the corresponding percentage of sugar either in tables made for the purpose, or we may calculate it, as will be seen hereafter. Afterwards a certain quantity of the solution is weighed (16·35 grs. for Duboscq's saccharometer, or 26·048 grs. for Ventzke's) and diluted to 100

centimetres cubic. After being decolorized and clarified, if necessary, it is placed in the optical saccharometer. By dividing the percentage of pure sugar, as found by the saccharometer, by the percentage of impure, as given by the areometer, the quotient obtained represents the quantity of pure sugar in the substance, if entirely deprived of water.

(*b*) The quantity of pure sugar in a solution, irrespective of the quantity of water, may also be obtained by using only an areometer and the optical saccharometer. The only process now in use for accomplishing this is that of Ventzke, which will be briefly noticed. I have discovered another process, which I have now used for nearly a year. As I have found it to be the most expeditious and the easiest process for testing sugar solutions, I have determined to publish it, and the object of this paper is to give a full description of the new process, so that chemists as well as manufacturers and refiners of sugar may have all the necessary information to enable them to use it.

Ventzke's process for testing sugar solutions, so as to obtain the pure sugar in the *dry substance,* is based on the fact that 26·048 grs. of pure sugar dissolved in water, so as to occupy 100 centimetres cubic, at 17½° C., gives a solution of specific gravity 1·1. Ventzke's saccharometer is made with quartz plates of such thickness that the above solution of pure sugar corresponds to 100° or 100 per cent. of the scale. To find the percentage of pure sugar *in the dry substance* of a sugar solution, Ventzke dilutes it so that at 17½° C. the specific gravity shall be 1·1. If it is now placed in his saccharometer, the number on the scale represents the percentage of pure sugar in the substance reduced to dryness.

As it is no easy matter to obtain a solution of sugar of specific gravity 1·1 at 17½° C., Ventzke has made a table by means of which the specific gravities at other temperatures are given. For instance, the solution which at 17½° C. has a specific gravity of 1·1, at 14° C., has a specific gravity of 1·1008 ; at 9° C., of 1·1018, and at 30° C., of 1·0964.

If we find the *apparent* expansion of a sugar solution of specific

gravity 1·1, for 1° C., we can obtain the *apparent* expansion for any number of degrees by multiplying the *apparent* expansion for 1° by the number of degrees required. The *apparent* expansion for 1° C. is the coefficient of *apparent* expansion, and is the difference between the coefficient of expansion of the sugar solution of sp. gr. 1·1 and that of glass, of which the areometer is made. An examination of Ventzke's table for correction of temperature shows that he has taken a variable coefficient of apparent expansion, which does not differ much from 0·00022 for temperatures below 17½° C., and from 0·00032 for those above that point. If we calculate a table with the coefficient 0·00026, the numbers obtained do not differ very materially from those of Ventzke's table. This coefficient is the one given by Mandelblüh (*Leitfaden zur Untersuchung, etc.*, p. 29) for solutions of sp. gr. 1·1, and is nearly the average between 0·00022 and 0·00032. The difference in degrees between the temperature required and 17½ is to be multiplied by 0·00026. The product is to be *added* to 1·1 if the temperature is *lower* than 17½, and it is to be *subtracted* if the temperature is *higher* than 17½° C.

By means of these data a table may be calculated which, in the absence of the one given by Ventzke, will serve to make the corrections for temperature of the solution of specific gravity 1·1 at 17½° C. There need be no fear of its correctness as compared with the one given by Ventzke, for, although this was apparently obtained by experiment, and although coefficients of expansion often vary in a slight degree for different temperatures, it is impossible to admit that for a variation of 20° C. there could be such a difference as exists between 0·00022 and 0·00032.

The necessity of obtaining 100 per cent. with a solution of pure sugar of specific gravity 1·1 at 17½° C. has given rise to Ventzke's saccharometers. Although there is no reason to regret the existence of these instruments, which, when made by good Berlin makers, are certainly the best saccharometers that can be had, we may remark that they do not differ in any essential particular from Soleil's saccharometer, and that it is quite as easy to obtain solutions of specific gravity 1·063, which correspond to 16·35 gr.

of sugar in 100 centimetres cubic, as those of specific gravity 1·1. Attention is called to this because many persons have the Soleil-Duboscq instrument instead of Ventzke's, and to them it may be useful to know that Ventzke's process can be applied to Duboscq's instrument by using a sensitive specific gravity scale, extending from 1·0615 to 1·0645. The coefficient to be multiplied by the difference between the temperatures required and 17½° is 0·00012 (See Mandelblüh, *op. cit.*, p. 29).

On this base I have calculated the following table for every degree from 8° to 27° C., carrying the coefficient to the fourth decimal.

Degree Celsius	Specific gravity.	Degree Celsius	Specific gravity.	Degree Celsius	Specific gravity.	Degree Celsius	Specific gravity.
8	1·0642	13	1·0636	18	1·0630	23	1·0624
9	1·0641	14	1·0635	19	1·0629	24	1·0623
10	1·0639	15	1·0633	20	1·0627	25	1·0621
11	1·0638	16	1·0632	21	1·0626	26	1·0620
12	1·0637	17	1·0631	22	1·0625	27	1·0619

The table calculated by Gerlach (Mandelblüh, *op. cit.*, p. 79) has numbers which vary too much for a difference of 1° C., as his coefficient of apparent expansion is on an average 0·00024 for temperatures below 17½° C., and 0·00034 for those above. These are very nearly those of Ventzke's table, and can hardly be applicable to solutions of specific gravity 1·063.

In conclusion, we may say of Ventzke's process, that although nothing can be simpler than its principle, it is open to the objection that it takes time to obtain exactly the specific gravity corresponding to the temperature observed. If the sugar solution is warmer than the water used, every addition of either affects not only the density but the temperature, which requires re-adjustment several times if an accurate result is to be obtained. Besides, it is impossible to test by this process solutions that are lighter than specific gravity 1·1, such as many wash-waters and saccharine juices.

The process which it is the object of this paper to describe

overcomes both these difficulties, as, in all cases, we have to make only one observation with the areometer, and one with the thermometer, and as there is no limit to the density of the solutions that can be tested by it.

PART SECOND.

Areometers.

Before proceeding to describe the new process for testing sugar solutions, we have to say a few words on areometers which will help to elucidate the subject.

According to the division of their scales, areometers may be classified as having an *even* scale or an *uneven* scale.

The areometers used by sugar manufacturers are those of Beaumé and Balling, which have an even scale, and the specific gravity areometer whose scale is uneven. To these we may add Twaddle's scale, which is only a specific gravity scale in which the unit is suppressed, and the remaining number is multiplied by 200.

Areometers with an even scale are those in which all the divisions of the scale are equal. As they are easier to make, and as it is also easier to verify their correctness, they have found universal acceptance and are much more extensively used than the others. In the process to be afterwards described, I have adopted an areometer with an even scale, not only because it is easier to verify their correctness but that it is possible to make use of them even after we have discovered that their scale is incorrect. This we shall see in the sequel.

Another advantage possessed by these areometers is that the numbers on their scales are simpler, which is a matter worthy of consideration, when we have to use them several times in the course of a day. The scale adopted is that of Balling divided into tenths, which gives sufficiently minute indications. To illustrate the advantage of having simple numbers on a scale, the following is appended.

Balling's scale	12	12·1	12·2	12·3	12·4
Specific gravity corresponding ..	1·0488	1·0492	1·0496	1·0501	1·0505

Balling's areometer gives directly the percentage of impure sugar in a solution, and on this account is sometimes called a *saccharometer*. To avoid confusion we will reserve this term for the optical saccharometer, and whenever we use the word *areometer* we shall mean Balling's, unless otherwise specified.

Areometers of all kinds can only give the density of a liquid. If Balling's gives with sufficient approximation the quantity of impure sugar in a solution, it is because the impurities which exist in raw sugars give liquids which have very nearly the same weight of matter in solution as there is in solutions of pure sugar of the same density.

The divisions of Balling's and Beaumé's scale, and those of the specific gravity areometer are mutually convertible into one another. One degree Beaumé is equal to 1°·801 Balling, 1°·8 being near enough for most purposes. Inversely, 1° Balling is equal to 0°·554 Beaumé. To convert the divisions of the specific gravity scale into degrees Beaumé, Francœur has given the following formula:—

$$*P = \frac{152}{152-d}$$

in which P is the specific gravity and d the degree Beaumé. This formula is incorrect, and it may be mentioned that the table in Ure's Dictionary (Article *Areometer of Beaumé*) is calculated from it. The correct formula is—

$$P = \frac{144}{144-d}$$

whence—

$$d = 144 - \frac{144}{P}$$

Bearing in mind then 1° Beaumé is equal to 1°·801 Balling, we can convert degrees Balling into corresponding specific gravities, and *vice versâ*, by replacing d in the above formulas by its value in degrees Balling, which we call D.

* For liquids lighter than water, Francœur's formula is correct, $P = \frac{146-d}{136}$, in which P is the specific gravity and d the degree of the Beaumé's areometer for such liquids.

$$P = \frac{144}{\frac{144 - D}{1{\cdot}801}}$$

whence $$P = \frac{259{\cdot}3}{259{\cdot}3 - D}$$

and $$D = 259{\cdot}3 - \frac{259{\cdot}3}{P}$$

Testing Areometers.—If we have an areometer which we know to be correct, it is an easy matter to test others with it, by taking two solutions, one corresponding to one end of the scale, and another to the other end, and by placing the standard instrument and the one to be tested successively in each solution, and seeing how nearly their indications correspond. If we have not a standard instrument, we can ascertain the specific gravity by means of a balance. If the areometer to be tested has the specific gravity scale, we may see directly how its indications in the two solutions correspond to those of the balance. If the areometer is Beaumé's or Balling's, we convert its indications into corresponding specific gravities, either by means of tables made for the purpose or for the formulas already given above.

I have found the following manner of taking specific gravities of liquids to be the most convenient. A pipette of, say, 20 centimetres cubic is placed inside of a small beaker glass. They are weighed together, which gives the tare for future operations. The stem of the pipette should be shortened so that it may not project too much above the beaker. Of course the pipette should be perfectly dry at the time it is weighed. In the next place, the solution of sugar whose specific gravity is to be taken, is brought to the temperature of 17½° C.; the pipette is filled with it to the mark on the stem and then placed in the small beaker glass. The beaker holding the pipette is then placed on the pan of the balance and the weight ascertained. The increase over the first weight is due to the solution taken up by the pipette. By dividing this by the number of centimetres cubic of the pipette we obtain the specific gravity of the solution. At the start we obtain the number of centimetres cubic in the pipette by filling it

in the manner described with distilled water at 4° C. The weight of the water in grammes is equal to the number of centimetres cubic held by the pipette.

When an areometer has been found defective, it should be returned to the manufacturer; but this is not always practicable, and we should be able to obtain accurate results even with an imperfect instrument. This is only possible, however, when the stem does not differ too much from a perfect cylinder, and when the divisions of the scale are equal to one another, even if they have not the proper length and if they are not in the right place on the stem.

It will seldom happen that the stem is not sufficiently cylindrical or that the divisions of the scale are not equal to one another. If there should be any doubt on these two points, they can be ascertained by compasses and callipers. If the areometer is one with an uneven scale, it is not possible to use it if defective, because the divisions being unequal, those of one portion of the scale are not applicable to another portion.

For a long time I was obliged to use exclusively areometers whose scales were not in their right places on the stem, and whose divisions were not of the proper length. This was because I use a scale extending from 5° to 15° Balling divided into tenths, and that there are no correct scales of this kind to be found in the market. I was then obliged to determine for every instrument its degree of inaccuracy, and to rectify every instrument by a special formula, as will be presently explained. At last, having obtained an areometer with a sufficiently fine stem and having loaded it with the requisite amount of shot, I marked on it the point corresponding to 5° and 15° Balling. Using this instrument as a standard, Mr. Henry Weinhagen of No. 152 William Street, New York, made several instruments for me which I found very accurate. The areometers begin at 5° Beaumé and end at 15°, every degree being divided into tenths.

To obtain a formula which will enable us to correct the indications of an imperfect instrument, we must prepare two solutions, one with a density not differing much from 5° Balling,

but not less than 5°, and the other with a density not differing much from 15° Balling, but not more than 15°. If we place the areometer under examination successively in the two solutions we shall get on its scale two points corresponding to these solutions. Let us call the lighter solution A and the heavier B, and let a be the division of the areometer corresponding to solution A, and b the division corresponding to solution B. The difference between the indications in the two solutions is $b—a$. If now we take the specific gravities of the two solutions, we can, by the tables made for the purpose or by means of the formula already given

$$(D = 259{\cdot}3 - \frac{259{\cdot}3)}{P}$$

find the degrees Balling corresponding to A and B. Let a' and b' be the degrees Balling corresponding to the specific gravities of A and B, the difference of the density between the solutions will be $b'—a'$. If $a' = a$ and $b' = b$, the scale is correct; if a' is different from a and b' different from b, but at the same time $b'—a' = b—a$, then the divisions have the proper length, but the scale is not in its proper place on the stem. In this case $a'—a = b'—b =$ the displacement of the zero, which we will call m. If $a' > a$, m is positive, if $a' < a$, m is negative. Then if we want D, the true degree Balling corresponding to d, the degree of the areometer to be tested, we shall have it by observing that

$$D = d \pm m.$$

If $b'—a'$ is different from $b—a$, the divisions of the areometer have not the proper length. The relation between the number of degrees of the areometer between the two points observed and the corresponding number of true degrees is $\frac{b'—a'}{b—a}$. Having this relation and the point of the areometer scale when the true zero comes in, we have every element we need. This zero must be at a distance from a equal to a'. By multiplying a' by $\frac{b—a}{b'—a'}$ we express a' in degrees of the areometer. If from $a'\left(\frac{b—a}{b'—a'}\right)$ we subtract a, we have the distance between the true zero and the zero of the scale expressed in degrees of the areometer—

$$m = a' \left(\frac{b-a}{b'-a'}\right) - a.$$

If $a' \left(\frac{b-a}{b'-a'}\right) > a$, m is positive.

If $a' \left(\frac{b-a}{b'-a'}\right) < a$, m is negative.

This quantity m is to be added to or subtracted from d, the degree of the areometer. The quantity to be obtained is to be multiplied by $\frac{b'-a'}{b-a}$ to obtain D, the true degree—$D = (d \pm m) \frac{b'-a'}{b-a}$

Numerical Examples: If we have two solutions A and B, we may suppose that an areometer to be tested will indicate 5° in solution A, and 14° in solution B. Let us also suppose that, after taking the specific gravities of the two solutions, we find that the corresponding degrees Balling are 5·5° for A and 14·8° for B. We have then $b - a = 14° - 5° = 9°$, and $b' - a' = 14{\cdot}8 - 5{\cdot}5 = 9{\cdot}3°$. Then $\frac{b'-a'}{b-a} = \frac{9{\cdot}3}{9} = 1{\cdot}033$, and m, the distance between the true zero and the zero of the aerometer expressed in areometer degrees, is $m = \frac{5{\cdot}5}{1{\cdot}033} - 5 = 5{\cdot}34 - 5 = 0{\cdot}34$. This, being a positive quantity, is added to every degree d of the areometer, and the sum is multiplied by 1·033, to have the true degree D.

$D = 1{\cdot}033\ (d + 0{\cdot}34)$. If we have another solution C, and on placing in it the areometer it indicates 13°·5, the true reading is

$$D = 1{\cdot}033\ (13{\cdot}5 + 0{\cdot}34) = 14°{\cdot}29.$$

Let us take another areometer. With solution A we have, say 6°, and, with a solution, B, 14°. From the specific gravity we calculate that the true reading ought to be for A 5·8° and for B 14·9°. Then $b - a = 8°$, $b' - a' = 9{\cdot}1°$, and $\frac{b'-a'}{b-a} = 1{\cdot}137$

$m = \frac{5{\cdot}8}{1{\cdot}137} - b = 5{\cdot}1 - b = -0{\cdot}9$. This 0·9, being negative, is subtracted from d, the degree observed on the areometer. The true reading is $D = (d - 0{\cdot}9)\ 1{\cdot}137$.

Williamsburg, New York, September 17, 1873.

(To be continued.)

ANALYSIS OF CRUDE SUGARS AND SYRUPS.

BY H. LANDOLT.

Translated by J. M. Merrick, B.Sc.

(Continued from page 659.)

III.

Analysis of Syrups.

The investigation of six syrups, with which the labours of the refiner close, gave the following results :—

A. *Determination of Sugar.*

The sugar was determined by polarization,* as follows :—

Syrup.	By Ventzke Landolt.	Soleil.			Accepted mean value.
		Landolt direct.	Invert.	Lotman and Landolt direct	
1	59·2	59·5		59·	59·2
2	58·5	59·2		58·8	58·8
3	57·0	56·8	54·5	56·8	56·8
4	55·7	55·6	55·9	55·8	55·7
5	58·1	57·6	55·2	58·0	58·0
6	52·1	51·6	49·8	51·5	51·6

Polarization gives the sugar contents of syrups and molasses with only approximate exactness, since in these products there is present no inconsiderable amount of other optically active substances, *ex. gr.* inverted sugar, aspartic acid, organic salts, etc. The total of these disturbing matters shows left rotation, and causes the sugar per cent. to show too small.

Inversion gives still less trustworthy results, since, by treatment of the salts with hydrochloric acid, organic acids are set free, which turn the ray of light partly left and partly right.

* On account of the strong color of the solutions, even after clearing with acetate of lead, it was necessary to give them half the normal strength. For inversion they were filtered over animal charcoal.

Since all these substances separate no suboxide of copper from an alkaline copper solution upon warming, it is preferable to determine the sugar in syrups by titration.

Should the syrups (which is not wholly impossible) contain small amounts of organic substances, which have a reducing action upon the copper solution, the percentage of inverted sugar will appear somewhat too large, and consequently the cane-sugar will be too small.

By the oxide of copper process this latter can in no case be found too high.

The following determinations of syrups were made with the help of Fehling's solution, in the manner indicated above, the sugar solution being first titrated direct and again after inversion. The first gave the amount of inverted sugar, and the second rendered the calculation of the cane-sugar possible.

Syrup. No.	Direct titration. Syrup in 100 c. c. solution.	Direct titration. Sugar solution required by 10 c. c. Fehling's sol.	Inverted sugar in per cent.	Titration after inversion. Syrups in 100 c. c.	Titration after inversion. C. c. sugar solution used for 10 c. c. Fehling's solution.	Cane Sugar in per cent.
1 ..	49·682	5·4 c. c.	1·86	·4763	15·7	61·75
2 ..	40·8480	6·5 c. c.	1·88	·5170	14·5	61·58
3 ..	38·3905	6·4 c. c.	2·03	·4864	16·0	59·11
4 ..	30·5975	7·5 c. c.	2·18	·5498	14·3	58·35
5 ..	27·6085	8·6 c. c.	2·11	·6699	11·4	60·19
6 ..	28·1170	11·05 c. c.	1·61	·3600	23·6	54·38

The number given of c. c., used for 10 c. c. of Fehling's solution is always the mean of three or four closely agreeing trials.

The annexed table shows a comparison of the percentages of sugar obtained by Fehling's test and by polarization. Since the former appears to be decidedly the more correct, it follows that, with syrups, polarization may give results considerably too low. The difference amounts, as is shown, to about 2·5 per cent.

Syrup.	Percentage of Cane-sugar.		Difference.
	By Copper.	By polarizing.	
1 ..	 61·8	 59·2	 2·6
2 ..	 61·6	 58·8	 2·8
3 ..	 59·1	 56·8	 2·3
4 ..	 58·4	 55·7	 2·7
5 ..	 60·2	 58·0	 2·2
6 ..	 54·4	 51·6	 2·8

B. *Determination of Salts.*

In order to determine these the syrups were carbonized in a platinum dish, the residue repeatedly exhausted with hot water, and the filtered solution, after the remaining carbon had been first burned in a platinum crucible, was evaporated in the platinum dish. Since in this operation the mass was at a red heat only a short time, no volatilization of salts was to be feared. The percentage of organic salts was reckoned, as explained before, by doubling the amount of ash obtained.

Syrup.	Substance used.	Ash obtained.	Ash in per cent.	Organic salts in per cent.
1 ..	4·226 grm.	·3990 grm.	.. 9·44 ..	.. 18·88
2 ..	6·0180 ,,	·6025 ,,	.. 10·01 ..	.. 20·02
3 ..	5·6600 ,,	·5920 ,,	.. 10·46 ..	.. 20·92
4 ..	6·1935 ,,	·6325 ,,	.. 10·21 ..	.. 20·42
5 ..	6·2710 ,,	·6200 ,,	.. 9·89 ..	.. 19·78
6 ..	7·9400 ,,	·7915 ,,	.. 9·97 ..	.. 19·94

C. *Water Determination.*

The exact determination of the water in syrups was made by completely desiccating them.

This operation is involved in many difficulties, since the viscous mass parts with its water on heating only with the greatest reluctance. It is needful, therefore, to mix the syrup with a large amount of pure, coarse quartz-sand or coarsely pulverized glass, in order to effect a complete subdivision of the mass. If this mixture be heated in the water-bath at 100° C., a week's time

may be spent in the drying process, and the mass may constantly lose weight during this period.

In order to hasten matters a stream of dry air was conducted over the substance in a tube, but two experiments made in this way gave no satisfactory result.

The application of a vacuum was therefore resorted to and a special apparatus constructed.

It consisted of a horizontal cylinder of sheet copper, through which runs a wide brass tube with projecting ends. One end of this cylinder is closed and the other open, but provided with a strong rim upon which an iron plate is laid which can be screwed down firmly by the help of a wrench.

By means of a ring of rubber an air-tight closure is obtained.

The space between the two cylinders was filled with water and served as a vessel for generating steam.

The substance to be dried was introduced into the inner cylinder and with it a deep vessel filled with some hygroscopic substance. Cocks were set in the two projecting ends, one of which was connected with an air pump and the other with a monometer. The exterior cylinder was 10 inches long and 8 inches in diameter, the inner 11 inches long and 4 inches in diameter. The apparatus was laid upon a small stove of sheet iron and was heated by a Bunsen burner.

One or two grammes of syrup were weighed between two watch-glasses, in one of which was some coarsely powdered glass which, with the help of a drop or two of water, contributed to the uniform distribution of the mass.

The watch-glass was then put into the drying cylinder previously charged with chloride of calcium, and a vacuum established up to above one inch of mercury.

The water in the outer cylinder was boiled under ordinary pressure.

While in this apparatus the desiccation of other substances went on very rapidly; the syrups, on the other hand required a long treatment.

When the water had been mainly exhausted, anhydrous phos-

phoric acid was put in place of the chloride of calcium and the heating continued until two consecutive weighings showed no further loss of weight.

In weighing it was necessary to keep the watch-glass carefully covered, since the dried syrup is an extremely hygroscopic substance.

The water determinations of the six syrups were carried on at the same time. The time required was four days.

The following table shows the results obtained.

Syrup.	Substance used.	Loss in drying.	Water in per cent.
1	1·3165 grm.	·1875	14·24
2	1·1740 ,,	·1720	14·65
3	1·6896 ,,	·2513	14·87
4	1·4322 ,,	·2557	17·85
5	1·8735 ,,	·3045	16·25
6	1·5928 ,,	·3345	21·00

Besides the exact water determinations are others which were made by means of hydrometers, according to the method previously alluded to, by dissolving 26·048 grms. of syrup in 100 c. c. of water and determining the specific gravity.

If this method gives with crude sugars values considerably too low, this must be the case in a higher degree with syrups, since here the amount of salts and other matters which cause the error is much greater.

The annexed table shows in fact that the areometer gives the percentage of water in syrups 4 per cent. lower than the direct determination.

Syrup.	Sp. gr. at 17·5° C.	Corresponding per ct. water.	Water by drying.	Difference.
1	1·089	11·1	14·2	3·1
2	1·0896	10·5	14·7	4·2
3	1·0894	10·7	14·9	4·2
4	1·0864	13·7	17·9	4·2
5	1·0879	12·2	16·3	4·1
6	1·0836	16·6	21·	4·4

The composition of the syrups in 100 parts is—

Syrup.	Cane Sugar.	Invert.	Sugar salts.	Water.	Undetermined.
1 ..	.. 61·8 ..	.. 1·9 ..	.. 18·9 ..	.. 14·2 ..	.. 3·2
2 ..	.. 61·6 ..	.. 1·9 ..	.. 20·0 ..	.. 14·7 ..	.. 1·8
3 ..	.. 59·1 ..	.. 2·0 ..	.. 20·9 ..	.. 14·9 ..	.. 3·1
4 ..	.. 58·4 ..	.. 2·2 ..	.. 20·4 ..	.. 17·9 ..	.. 1·1
5 ..	.. 60·2 ..	.. 2·1 ..	.. 19·8 ..	.. 16·3 ..	.. 1·6
6 ..	.. 54·4 ..	.. 1·6 ..	.. 19·9 ..	.. 21·0 ..	.. 3·1

SUGAR MACHINERY.

From "*Iron.*"

(Continued from page 631.)

The ponderous rolls are suitably geared together by powerful spur-wheels, for synchronous action, the upper roller receiving the motion from the powerful intermediate duplicate wheel-train, and communicating it to the lower ones. The connection between the main gearing shaft and mill is made by means of a double coupling, which permits the upper roller to have that certain amount of freedom and play in its bearings, which may be necessary from time to time in the treatment of the irregularities in the cane-feed. Means also are provided for regulating the distances or intervals between the bottom rollers and the upper ones, by means of suitable set-screws in the side of the frame, whereby the axis of the rollers can be brought nearer together or set farther apart, and thus the degree of crushing to which the canes are subjected in passing through the mill can be properly adjusted. The dimensions of the rollers vary, of course, according to the magnitude and extent of the works: assuming that the work of an ordinary plantation required a mill of moderate size, equal to an out-turn of about 8 or 9 tons of sugar daily, the width or length of the rollers would be about 5 feet, and their

diameter about 2 feet 2 inches. But rollers are made up to 7 feet in length, and weighing about 11 tons each.

The prime-motor for such an average mill (8 to 9 tons daily) is an ordinary high-pressure beam-engine, with a 16-inch steam-cylinder and a 3-feet stroke; and provided with an especially large and heavy fly-wheel, operating a second and third motion-shaft by pinions engaging n spur-wheels, the third and last or main-shaft of this powerful diminishing gear being coupled to the upper roller of the cane-mill, as described. The exhaust steam of this steam-engine is employed, at a pressure of from 3 to 7 lbs., for assisting to heat the clarifiers, or the like uses.

Messrs. Manlove, Alliott, and Co. manufacture their engines, mill-work, and cane-mills with especial regard to durability, massiveness, and solidity, in view of the severe strains to which they are of necessity continuously subjected. In the early times of sugar manufacture the frames and rollers were originally alike made of wood; and in some cases the rollers were arranged vertically; but, under the changed conditions of this industry, and the necessity, for its profitable working, of obtaining the largest percentage of juice possible in the crushing, the present improved cane-mills, made entirely of metal, and with solid framing and bed-plates, have become essential. Mills with as many as five rollers have been tried, with the view of obtaining more juice by four compressions; but the increased complication and extra cost involved have, on the whole, been found to counter-balance this advantage, and therefore the three-roll cane-mills retain their position.

As the juice is expressed from the canes it drains down between the rollers into a receptacle in the bed or foundation-plate, suitably formed to convey it away by a conduit of the juice-tank, adjoining the intermediate gearing, whence it is raised into an elevated cistern, for future treatment, by a pump driven by a belt or otherwise from the engine-crankshaft. It may be noted that as, on the one hand, too high temperatures have an injurious effect on the cane-juice, so, on the other, the expressed juice is excessively

liable to fermentation, especially at the customary temperature in the tropics; wherefore it is found very desirable to elevate the temperature of the juice, from the very commencement, to such a point that fermentation is not so rapid and destructive. This is effected by forming steam-chambers in the bed of the cane-mill, and in the trash-turner. Of course it is also essential that the cane-juice should be removed from the mill in proportion as it is formed; but as the yield from crushing is by no means constant, but somewhat variable, special devices have been introduced for the adjustment and regulation of the pump-stroke. In this respect one of Messrs. Manlove, Alliott, and Co.'s recent improvements is the adaptation of an improved steam-pump, whereof the speed is regulated solely by the depth of the juice in the tank: thus they avoid the evils and injurious effects of air becoming mixed with the juice in the pump-suction.

No system of mere compression can entirely eliminate all the sugar-juice contained in the cane, and it is unavoidable that a certain proportion thereof should remain within the crushed fibres of the megass; but in fairly efficient mills this waste should not exceed 20 to 25 per cent.

Various improvements on the above mechanical treatment have from time to time been introduced: steaming the canes at once when cut, with a view to the immediate coagulation of the vegetable albumen and fixation of the elements most active in fermentation: the disintegration and comminution of the canes by reduction to the condition of saw-dust, and subsequent subjection to the action of steam and hydraulic pressure; the cutting or slicing of the canes into short lengths to be forced by a solid plunger through a perforated cylinder; all these and other inventions have yet failed to supersede the purely mechanical process of the roller cane-mill which has been brought to such perfection of strength and power by Messrs. Manlove, Alliott, and Co., having in view the special points which are essential to the thorough efficiency of a sugar-mill, namely, that all the fixed and working parts should be of such strength that fracture

through choking with too much material or hard and extraneous substances is impossible; that whatever pressures are most suitable to the material under treatment should be attainable at will by adjusting the distances apart of the rollers; that the arrangement of the journals and bearings of the rollers themselves should be such as to allow of their easy removal, and that all should be perfectly and readily accessible for cleansing and other purposes.

It is stated that by the "diffusion" process, which has been employed on a very considerable scale, very successful results have been obtained in the extraction of 95 or 96 per cent. of the saccharine matter contained in the cane. This diffusion process depends upon the well-known principle of *endosmose* and *exosmose*, between liquids separated by an organic membrane, whereby soluble salts will pass from one to the other, until the two solutions are of equal degree of impregnation and saturation. Thus by treatment of the organic cells of the sugar cane with several successive pure waters, almost the whole of the sugar can be eliminated therefrom. For this purpose the canes are cut up into very thin slices, so as to subject as large a cellular surface as possible to the direct influence of the water; the slicing being effected by knives attached to a revolving disc, to which the stems are fed forward at an angle so that the severance is oblique. The "diffusion battery" is an apparatus consisting of a series of closed vessels placed side by side, and provided with feed-apertures for the cane slices, movable covers, manholes for the removal of the spent canes, and various sets of piping and cocks, for interchanging the contents. There is also an heating apparatus, and a cold water feed cistern, in connection with the battery; the former for filling any of the vessels with hot water or diffused juice, and into which the saccharine solution can be forced for the purpose of being heated; the latter to supply pressure to force the diffusion juice into the heater, or from any one of the vessels of the battery to another. Notwithstanding the apparent advantage of the extraction of the bulk of the sugar contained in the cane, there are concomitant disadvantages which

may be held to counterbalance it; such as the greater degree of dilution of diffusion-juice as compared with mill-juice; the decreased value as fuel of the spent slices, compared with the megass; and the greater quantity of fuel requisite for the increased evaporation of water in the concentration of the juice.

(*To be continued.*)

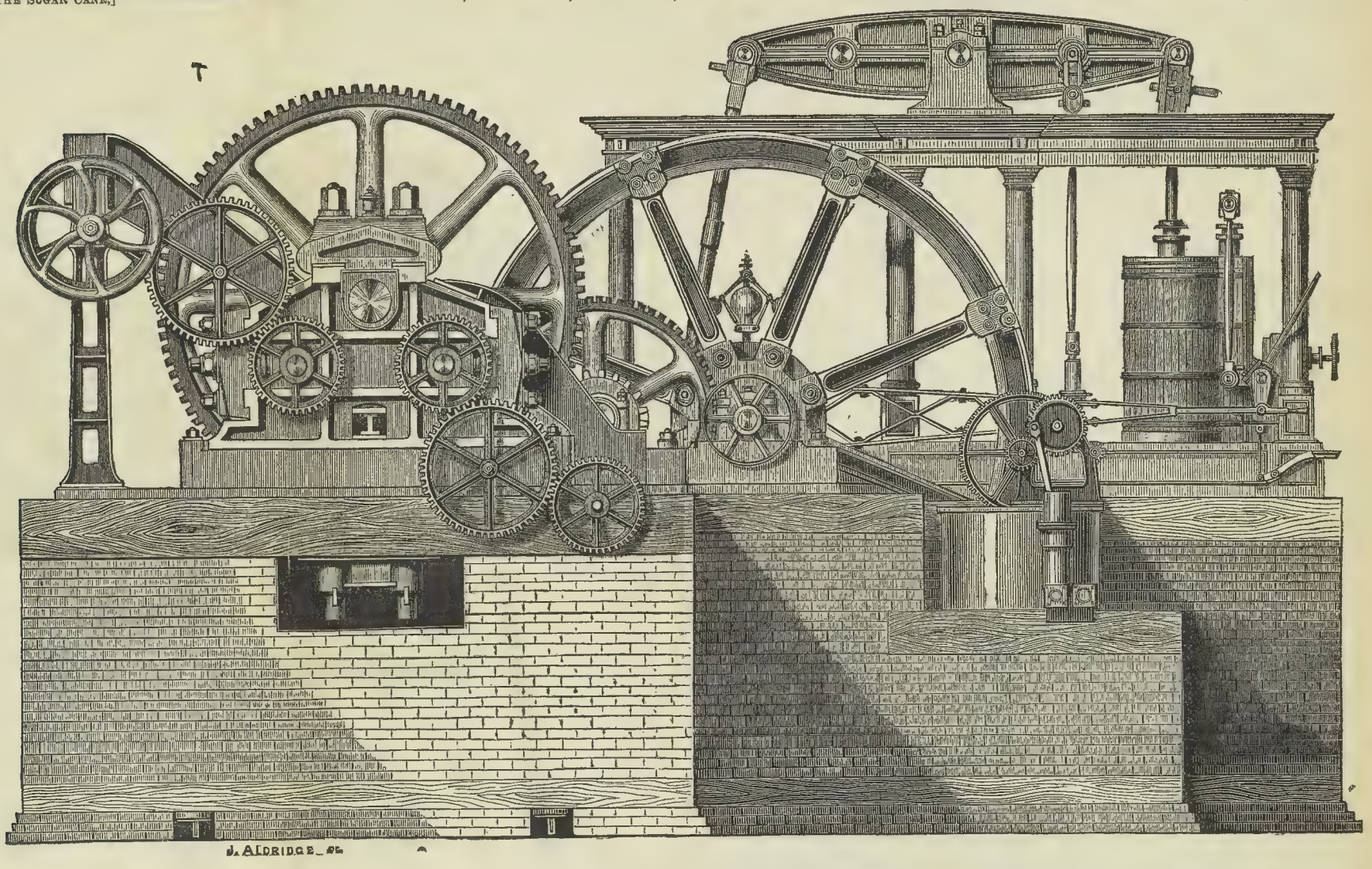
TRASHING CANE.

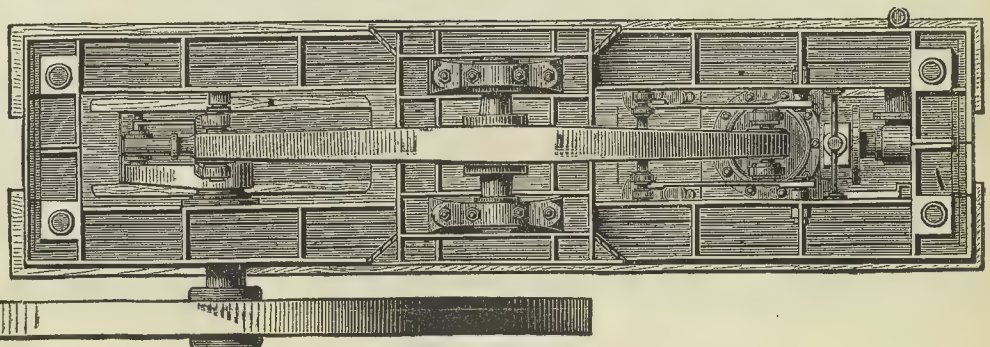
From the *Queenslander*.

I would say that in cane trashing, personal observation and common sense are the best guides for each individual.

My own experience in the matter, though far from placing myself in the scale of authority with Messrs. Scott, Strachan, M'Donald, &c., is this: Presuming we have a dry winter, and the cane is not too thick on the land, Bourbon cane will trash itself as each joint ripens, and will make better sugar and more of it than if trashed by hand; but if a heavy crop and a wet season, you must trash to get the best results. Ribbon cane of any variety should be stripped, as it does not shed its leaves readily.

As a general rule, I think cane growers strip too high, and send too much top to the mill. When speaking of the protection from frost afforded by non-stripping, it seems to be forgotten that it is not the stalk that suffers first. It is the leaves or lungs of the plant that receive the check, and the best safeguard is effectual drainage and cultivation. Cane does not suffer nearly so much when well banked up, so as to discharge the surface water. I see that Mr. de Kock advises the banking up of cane, and from the little this gentleman says in his letter, I should be inclined to think a better authority has not been quoted in Queensland. Referring to the use of sulphur, I cordially agree with him that good lime is all that is required if properly applied, and that bisulphite, sulphur in any form, soda, and all the other supposed





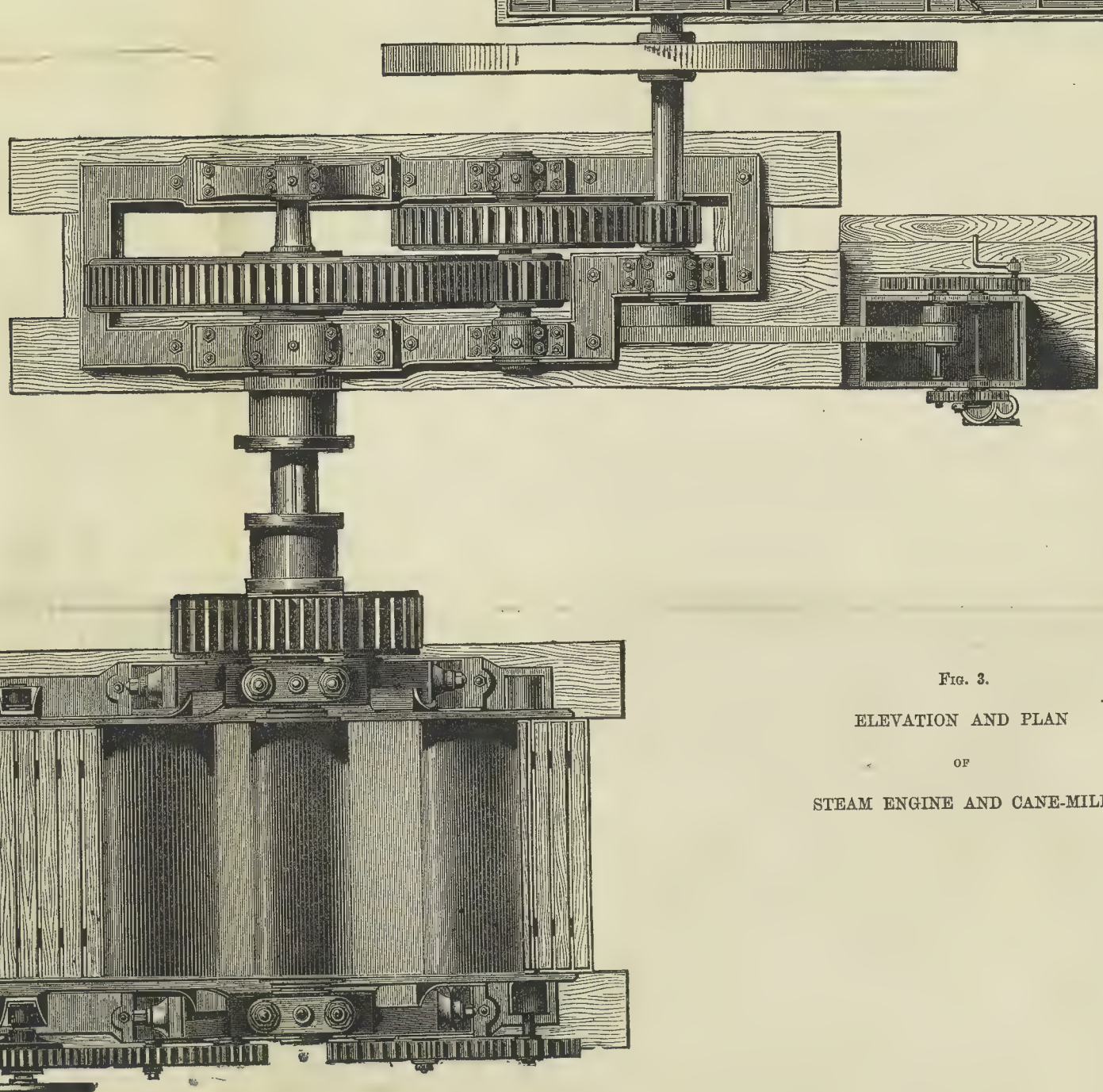


FIG. 3.

ELEVATION AND PLAN

OF

STEAM ENGINE AND CANE-MILL.

mysterious ingredients which are known by the name of "chemicals," are at best doubtful agents, and besides doing harm, add to the expense of sugar making. I have used clay batter with good effect, but it takes too much time, and does not answer with tubular clarifiers. There is the old adage of sugar being made in the field; but I fancy the treatment of the juice in our boiling houses has a great deal to do with the different yields in Queensland.

W. E. BURRELL.

Doughboy Creek, August 4th.

TRASHING CANE IN DEMERARA.

In reference to a question in the *Queenslander*, "To Trash or Not to Trash?" I beg to state the following facts: I was nearly three years an overseer in Demerara. During that time I had frequent opportunities of seeing the effect upon canes which had been left untrashed, through scarcity of labor or press of work, for even three or four months, and there was an invariable falling off in density when they were ground. The question of trashing as superior to leaving the cane dirty was so universally settled that I never heard any controversy on the subject.

EDWARD HAWTREY.

North Quay, Brisbane, August 1.

Possoz has patented in France the treatment of sugar residues with lime, and the carbonation and precipitation of the dissolved lime by acid, phosphate of lime, phosphate of alumina, and by phosphate or carbonate of ammonia.

MAKING SMALL QUANTITIES OF SUGAR.

BY MR. SCOTT, BRISBANE.

The following observations from a letter in *The Queenslander* may be of interest to our readers:—

"Sugar for home use can be made with very rough appliances.

The great requisite is good cane. We could not advise beginners to attempt to make sugar from canes of less than 9° density. Squeeze out the juice if possible, and this can be done very well by three rollers of hard wood turned by a lever, or better still by one of the patent mangles in common use in farm houses. Where pigs are kept it does not much matter whether all the juice is taken from the cane; they will extract all that remains and get fat upon it.

In whatever way the juice is extracted it should fall at once into a vessel kept at about 200°, or just below the boiling point. This is necessary to prevent fermentation, which commences as soon as the canes are bruised. Juice from clean cane of from 9 to 10° density should give from 1 to 1½ lbs. of good brown sugar to every gallon of liquor, besides syrup or molasses—and there are few better things set upon the farmer's table.

As soon as the required quantity of liquor has been secured—and from 10 to 20 gallons make a very fair boiling—it has to be tempered with lime in the manner described by Mr. Scott. By adding lime mixed with water or juice to the liquor, we curdle a large proportion of the impurities natural to all cane juice. They either curdle with the lime and fall to the bottom, or rise in the form of scum to the surface, and are skimmed off, and the clear liquor is then drawn off (being careful not to disturb the sediment) and boiled to granulation point, and as rapidly as possible.

Upon a block of wood crack, or rather flatten, the canes with a common tomahawk, then cut them into pieces about an inch or more long; previously having a large vessel, or several small ones, half full of boiling water, into which put the cut canes immediately they are prepared. This instant immersion is very essential, as the saccharine juices rapidly oxidate after being so treated. Fill these boilers with the chopped canes, leaving the water about an inch over them, which boil for (say) two hours and a half. Then strain off the liquor—first with a coarse sieve, and afterwards through a very fine one; or this may be done by suitable cloth.

(*To be continued.*)

THE SUGAR MARKET DURING 1873.

In reviewing the course of the sugar market for the year which has just closed, and comparing it with that of previous years, the feature which at once arrests the attention is the cheapness of sugar. Coal, with iron, copper, and most of the metals largely used in manufactures have throughout the year been at almost panic prices; corn, cattle, potatoes—almost every article of diet has become costly—in fact, nearly the whole of those multitudinous necessities, luxuries, and conveniences which are attendant upon man's wants have, during the past year, experienced such an eager drain that they have become dear. Sugar forms an almost solitary exception. Sugar, which is perhaps more directly dependent upon coal, machinery, and labour for its production in a pure and marketable form than any other human commodity, has not only failed to advance in a ratio proportionate to the increased cost of its manufacture, but has actually declined to a point which we venture to say is lower than has ever been reached before. Formerly regarded in the light of a luxury, the qualities of sugar have long commanded for it a position as an article indispensable to mankind, and it now bids fair to be regarded as one of the cheapest forms of food.

It is impossible to explain this phenomenon of exceptional cheapness on the supposition that the demand for sugar during the past year has been slack, for statistics assure us that the consumption, in England at least, is advancing with giant strides, and now equals about 60 lbs. per head. And although at first sight a high state of material prosperity throughout the country might appear to favour the consumption of alcoholic beverages to the partial exclusion of tea, coffee, cocoa, and the ordinary vehicles of sugar, yet figures prove that it has been sufficiently great to afford increased libations of both descriptions, to the detriment of neither, whilst it must be further borne in mind that the low price of sugar, and the comparatively high price of malt, have caused a greater quantity of the former to be used for brewing.

Certainly the British public have had to thank the Government during the past year for a further remission of the duty; but after full allowance is made for this circumstance there is yet much to

explain. We are doubtless one step nearer a solution of the problem when we note that the importations of sugar into Europe during the year have been very heavy, and that the same may be said of the continental production, the total increase upon last year's amounts being represented by the large figures of 126,000 tons. But as regards England, we believe that the depressed state of our sugar market is largely owing to another and entirely artificial cause.

The great increase of the duties in France has magnified the bonus, which the French refiners have always obtained on the exportation of their refined sugar, an advantage which is still further increased by the continuous development of the beetroot industry, since it is from this sugar that results can be obtained which have no correspondence with the estimated yields as determined by the colour.

With these weapons in his hand, therefore, the foreigner has been invading our markets. Should the contest continue much longer upon such unequal terms there will be serious danger of his succeeding in obtaining the monopoly of the British market, and it is easy to divine what this portends towards the consumer. Let us hope, however, that the respective Governments will, ere then, be roused to take action in the matter, and that, by beneficent legislation, they may step in to avert the ruin of the British sugar industry, a catastrophe which could have as its results no other than the permanent oppression of the English consumer and the spoliation of the French tax-payer, all for the aggrandisement of the French refiner.

The past year has throughout witnessed a large stock of sugar in the United Kingdom, the lowest point being, at the beginning of April, with 127,000 tons; and the highest, in the middle of September, with 231,000 tons. Imports have, as already stated, been large, and the consumption has been increasing in a very satisfactory manner. With regard to price, the course has been almost uninterruptedly downward, the latest quotations being:—for No. 12 Havana, 26s. to 26s. 6d. per cwt., against 28s. at the end of 1872; fair to good refining Muscovadoes, 22s. to 22s. 6d., against 25s. to 25s. 6d.; middling to good brown Bahia, 18s. to 19s., against 21s. to 22s.; and for common refined lump, 33s. to 33s. 6d., against 39s. to 39s. 6d.

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☞ The writers alone are responsible for their statements.

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NOTES ON THE HISTORY OF SUGAR.

By H. A. Smith.

1.—Cane Sugar.

The few following pages on the history of sugar are inserted in the hope that they may prove interesting to our readers. It is always interesting to know the history of those substances with which we have to deal, and to see how, from very small beginnings, they rise gradually in many cases to great manufactures.

It would be difficult, if not absolutely impossible, to name the time when sugar first became known. The sweetness-giver of old was honey, but at least four centuries before Christ sugar was a recognized article, certainly very rare, yet still known.

Many denied that it was known at all to the Greeks and Romans, yet this assertion goes for nothing, as Pliny takes notice of it as coming from Arabia and India; he says:—

"Arabia produces sugar (*saccharon*); but that from India is more famous. It is a kind of honey got from reeds (*in arundinibus collectum*), white like gum, and is crisp in eating. The largest bit is no larger than a filbert nut. *It is only used in medicine.*"*

Sprengel† also, in his "History of Medicine," says:—"The Arabian physicians often talk of *tabaschir*, or of sugar got from the bamboo, which was without doubt real cane sugar, and the same

* Pliny xii. p. 8. † History of Medicine. Vol. II.

substance the Greeks called *μέλι καλάμινον* (reed honey) and *ἅλς Ἰνδική* (Indian salt)." All, however, agree that at that early time it was only used in medicine.

Hoefer, in his "History of Chemistry,"‡ says, in regard to the quotation from Pliny, given above:—"What is this honey, got from reeds, white like gum, and crisp in eating, if it be not sugar? The reeds in question are a kind of sugar cane. It could not be gum, because the *saccharon* is sweet, as is honey. This passage is completely confirmed by Dioscodorus, Galen, and more lately by Paul d'Egine."

Coming to later times than those of Pliny, we find sugar to have come at last to be no more merely used for medicine, but to be required in such quantities that a refinery is at work. Bartholomée l'Anglais, whose work, "De Rerum Proprietatibus," was translated into French by Jehan Corbechon "in the year of grace mil CCCLXXII," has the following passage:—

"Sugar is in Latin called *sucara*, and is made from reeds which grow in the marshes near the Nile; and the sugar of these reeds is sweet, like honey; and the sugar is got by being prepared by fire, in a similar manner as salt is got from water; for they pound up these reeds, and then place them in a boiler over a not very strong fire, where, on the top, it becomes like scum, and then the better kind goes to the bottom; and that which is bad and full of scum stays above, and is not so sweet as the other, and is not crisp to the teeth in eating, but is very watery. The good sugar is placed in good round vessels to dry in the sun, and there it hardens and becomes white, and the other remains yellow."*

This is an interesting description of the old manner of conducting a "sugar refinery!" Prepared in a manner similar to that in which salt was got from water, points to the breaking up of the canes and boiling with water over a slow fire; the removal of the scum, and the use of the *sun* instead of *animal charcoal!* This is more than 500 years since. We have here advanced a little since

‡ History of Chemistry. Vol. I. p. 188.

* "Histoire de Chemie." Hoefer. Vol. I., pp. 424, 425.

the time when it was prepared evidently as a medicine. Whilst honey was the sweetener, the sugar was the astringent!

2.—On Beet Sugar.

To Berlin must be ascribed the honour of having sown the seeds of this great industry. In that town, in 1709, André-Sigismond Marggraf was born—the discoverer—it might almost be said the *inventor*—of the sugar-beet. The following passages from his great paper, communicated in 1745 to the Academy of Berlin, will be full of interest to all, and have never yet, I believe, appeared in the pages of *The Sugar Cane*.

The title of Marggraf's paper was, "*Experiments made with the design of determining the amount of real Sugar in the different plants which grow in our countries.*"

In experimenting on various plants with the design of getting one from which sugar could be procured, he found that in the first class must be placed beet-root and the carrot. He then found that the difference between this sugar and that of cane sugar was very trifling.

"The plants," says Marggraf, "which I have submitted to a chemical examination for determining the sugar in their roots, and in which I have really found it, are by no means of foreign production; they are plants which are born in our countries as well as in others in large quantities, common plants which spring even in a common earth, and which have no need of a very great culture. These are the white beet or perry, the parsnip (*Sisarum Dodonæ;—Daucus carotta*), and the red beet. The roots of these three plants have furnished me up to this time with a very copious and pure sugar. The first marked characteristics which indicate the presence of sugar contained in the roots of these plants are, that the roots being cut into bits and dried, have not only a very sweet taste, but that they ordinarily show, under the microscope, white crystalline particles which take the form of sugar.

"As sugar dissolves even in spirits of wine (hot), I have thought that this power of solution would perhaps serve to separate the sugar from foreign matters; but to assure myself previously how much sugar could be dissolved by the most highly rectified spirits

of wine, I mixed in a glass two drachms of the whitest and best sugar, well pounded, and mixed it with four ounces of the most highly rectified spirits of wine; the whole was strongly digested at a temperature nearly boiling, after which the sugar was found to be entirely dissolved. When this solution was cold again, I filtered it and put it in a glass, well closed with a cork stopper, when, having kept it carefully about eight days, I saw the sugar deposit itself in beautifully formed crystals. But it is necessary to remark that the success of the experiment requires the employment of most carefully rectified spirits of wine, and that the glass as well as the sugar should be quite dry; without these precautions, crystallization is very difficult.

"That being done, I took the roots of white beet cut into slices and dried them, but with care, so that they should not give off the least empyreumatic smell. These were then accordingly reduced to a large powder; eight ounces of this power were then dried, and put in a glass which could be corked; upon them was poured sixteen ounces of highly rectified spirits of wine, and which ignites gunpowder. The whole was then digested over a fire, being kept just at the boiling point of the spirits of wine, stirring from time to time the powder which had collected at the bottom. As soon as the spirits of wine commenced to boil the glass was taken from the fire, and the whole mixture immediately poured into a small linen bag, from which I strongly expressed the liquid it contained; I then filtered the expressed liquor still hot, emptied the filtered liquid into a glass with a flat bottom, closed with a cork stopper, and kept it in a place of moderate temperature. At first the spirits of wine become muddy, and, after some weeks, a crystalline product is formed, having all the characters of sugar, passably pure, and composed of compact crystals. These crystals were dissolved anew in spirits of wine, and by this means obtained still more pure.* What merits remark in passing is, that the greater quantity of the sugar separates from the spirit of wine

* Marggraf considered that this would be a very good method for determining if any plant contained sugar, and if so, in what quantity.

by crystallization, and that the resinous part remains behind. Further, it appears that in this operation a solution of quick-lime is not at all necessary for drying the sugar and giving it body, but that *the sugar exists completely in the crystalline form, at least in our roots.*"

It may not be out of place to add here a quotation from a book entitled "Waste Products and Undiscovered Substances," by P. L. Symmonds, in regard to the manner in which Marggraf first found and developed sugar-beet :—

"Marggraf found that an unsightly weed, growing wild on the shores of the Mediterranean, contained a small quantity of sugar and a large proportion of soda. By transplanting and careful culture, a large part of the soda was eliminated, and potash substituted in its place, and the quantity of sugar considerably increased. The weed was transplanted into the sugar-beet, and an industry established which has proved to be of great value to the European countries where the beet-root sugar is made."

The whole of the paper sent to the Berlin Academy would be well worth translation and insertion in *The Sugar Cane*, and I trust I may at some future time be able to get this done; but at present I must simply leave the subject incomplete as I leave it here, merely bringing it into notice as the work of a German chemist who may be said to be the founder of the great manufacture, steadily increasing year by year, of Beet-root Sugar.

ON THE BEST MEANS OF INCREASING THE YIELD OF SUGAR ON OUR WEST INDIA SOILS.

By Dr. T. L. Phipson, F.C.S.,

Member of the Chemical Society of Paris, &c.

The only means of increasing the present yield of sugar on our West Indian soils consists in obtaining an accurate knowledge of their chemical composition, and prescribing the treatment to which

both theory and practice point as the proper method of realising this desirable object.

In my recently published paper* I have shown what important deductions can be drawn from the relative amounts of lime and magnesia found to be present in any of these soils. It is a singular thing that I should have been forced to conclude from the whole of my remarks on this subject, that magnesia is evidently inimical to a high yield of sugar, since many years ago something similar was arrived at with regard to *goitre* in Switzerland by Dr. J. Grange†: wherever the water of the springs showed much magnesia, there *goitre* was plentiful. Now, on the contrary, when magnesia exists in large quantity in the West India soils, there sugar is not plentiful. I have recently discovered what I consider to be the source of the magnesia in the whole range of the West India Islands and the mainland. It is a kind of augitic or hornblend rock widely dispersed through this alluvial soil, a sort of potstone, which appears to pervade all the claylands of this immense district; sometimes it shows itself in rounded nodules, more or less weathered, and varying in size from that of a hazel nut to that of a hen's egg; generally it is so intimately incorporated with the clay that it is difficult at first to put it in evidence. I am now occupied with the analysis of this widely diffused stone, and will make known its composition and properties very shortly. No doubt exists in my mind that it is the principal origin of the magnesia in our Western cane soils, and it is only those soils in which lime is present in about eight times the quantity that magnesia is, that will yield large crops of sugar with ordinary treatment. The only safe way of adding lime to the cane soils of the West India Islands and Demerara is by means of the Urban cane manure, of which I have before spoken. The addition of lime by itself is not calculated to do much good, and may do serious harm, as these soils are not rich enough in humus or

* Phipson: Observations on the Agricultural Chemistry of the Sugar Cane. London: Ranken & Co. 1873. Page 19 *et seq.*

† Grange: Archives des Missions Scientifiques. Paris, 1855. Page 665.

organic matter. In the greater number lime has become essential from long culture; in others, almost virgin soils, lime, though present to the extent of rather more than 1 per cent., is still requisite, because the presence of the weathered hornblend element brings the magnesia up to an equal, or even a larger figure.

In soils of a dry nature—*i.e.*, those which contain much sand united with the clay, and which suffer much in moderately dry seasons—it would be well to try the effect of distributing the Urban manure by irrigation. It is of so fine a nature that it can easily be mixed with water and pumped on to the soil, care being taken that the orifices of the tube are large enough to admit the passage of the small particles of bone meal present in this manure.

In stiff clay soils the Urban manure must be well worked in, and a layer, about one foot in depth, of more porous soil will be thus produced. The admixture of sand and limestone would here prove beneficial sometimes; but I am convinced that, properly applied, the Urban manure alone will do its work perfectly. It supplies everything that the cane itself requires and that the soils require, so that in my opinion nothing more suited to our West Indian colonies was ever produced; and if it fails we may rest assured that the fault lies in the general treatment of the soil or management of the estate. To produce an immediate effect it must, of course, be used liberally; some planters have not done this, judging from its powerful odour that it was a very strong stimulant. It has, however, little or no stimulating action, hence it may be largely used, and its use must be persevered in for some seasons before all the benefits it is capable of supplying can be realised; though, in several instances, its effects have been very remarkable in the first and second seasons. In conclusion, then, of the present paper, the best and, in my opinion, the only means of increasing the present yield of our West Indian soils consists in overcoming the influence of the magnesia by means of a proper kind of manure properly applied.

The Cedars, Putney, London, S.W.

A CHAT ABOUT SUGAR.

By W. Anderson Smith.

Perhaps none of the great changes in diet among the people in modern times, can be compared with the wonderfully rapid advance in the consumption of warm drinks, from tea and cocoa to toddy, and the corresponding demand for sugar, with which to make them palatable to northern tastes. Sugar is essential to modern life and modern modes of feeding, and may be looked upon as in many ways an antidote and a beneficial *per contra* to the injurious nervous effects of tea and coffee. Such a great and rapid demand cannot have arisen without some real necessity of the human body being supplied, and sugar does supply such a necessity. It is the readiest, and one of the cheapest and most effective modes of introducing breath-foods, or heat givers, into the system, prepared for immediate absorption, and saving unnecessary force in its acidification. But although the consumption of sugar in Great Britain has reached such an important figure, a calculation of the quantity required to supply the carbon demanded by the population in their food, will how how far any foreign article must fall behind native products in supplying he nation's needs.

Let us take the present population roughly at 32 millions, and calculate a family as averaging five, of whom two are adults and three children, and we will approximate to the truth. For ordinary work we take 1 lb. of carbon as necessary to the system, or say 17 pounds of sugar per week and 884 lbs. per annum. This for a population of 32 millions, taking a family of five as equal to three-and-a-half adults, would give us, again roughly, $8\frac{3}{4}$ million tons of sugar as required to supply the needed caloric to the nation. Now the present consumption of the kingdom may be taken at 700,000 tons per annum, or equal to 1 in $12\frac{1}{2}$ parts of the necessary supply. This, considering the readiness with which mankind have taken to the sweets of the tropics, shows a possibility of the demand for sugar increasing still further and even to an unlimited extent with advancing civilization, more especially as a taste for the luxuries

of life spreads among the humbler classes. To its proper extension also there is necessary increased comfort among the people, and a readiness to transfer the money now spent on sugar in its metamorphosed form of alcohol, to its more direct purchase. Seventeen pounds of sugar at fourpence would cost 5s. 8d., a sum commonly spent by workmen per week on spirits, while it would supply his family with the bulk of the necessary heat-givers in a palatable form, and throw on the market, in a wholesome shape, a quantity of grain now consumed in a very questionable one.

But while admitting the probability of a vast increase in sugar consumption direct, we must remember that the nation procures a great quantity in its indirect shapes, and indeed but for the more agreeable nature of the tropical production might dispense with it altogether, as it did but a few generations since. In fact, there are parts of the kingdom where sugar has only been introduced within a quarter of a century, and thousands of our fellow-countrymen have probably never tasted it even now. Still we must allow that it has succeeded in getting a strong hold on the affections of the people, and without knowing whether it supplies heat or nourishment, millions will continue to purchase it. There is one point, of a strictly legislative character, that is likely greatly to add to its demand, and that is the recent laws against adulteration. We have every reason to believe that the possibility and even probability of getting tea and coffee of an innocuous character, at any rate will greatly increase the sale alike of the cup that cheers and its customary ingredient. And the more the latter is mixed with it the better, for the continued consumption of tea, increasing in quantity and strength, by many sections of our countrymen, and more especially women, is likely to prove highly deleterious without it.

One source of heat-supply to which an advancing civilization will direct more and more attention is that of puddings, to which plenty of sugar is added. Our dinners, even of very humble families, are not considered complete without some form of starch, such as tapioca, arrowroot, or sago, or the improved preparations of Indian corn or rice. These add greatly to the amenities of the ordinary dinner table, and might far more generally than they do take the

place of beer or spirits, and warm the heart of the diner with advantage both to purse and person. A copious supply of sugar with these is indispensable, and together they supply the system with carbon in a delightful form and at very slight expense. As the drinking habits of the country, now successfully driven from the tables of the better classes, become tabooed at the board of the working classes, these simple and agreeable articles will be introduced; and the tendency of the age is decidedly in this direction. Again, as the spring and summer approach, the sensible world will more and more devote themselves to the consideration of those pleasant blood-purifiers (to which sarsaparilla connot be compared in value) rhubarb and green gooseberries, preparing the blood for the changing seasons, and requiring plates heaped up with sugar to satisfy the palates of the youngsters, who acknowledge, with returned plates, their practical value.

Of late years the medical faculty have sensibly insisted upon the value of porridge in dietary, more especially for the young, and the taste for this sound diet is spreading among a class in England not hitherto given to it. A difficulty in the way of their wise endeavours is that of getting wholesome milk with which to sup this hasty pudding, and many have taken to sugar as a pleasant substitute, that is at least of unquestionable purity. Even those who patronize instead the milk sent out in tins by the Aylesbury and other companies, are good customers to the sugar producers, as quite one third of every tin is made up of sugar with which to keep it fresh. This leads us to consider the vast amount of sugar employed by great houses, such as Crosse & Blackwell, on account of its invaluable preservative action. Tons upon tons are used in the preparation of the countless fruits sent out over the land to gladden the hearts of old and young; for what is an English table without black currant jelly, or a Scotch tea without marmalade. The use of all these, too, is advancing in an ever-increasing ratio, for the nation seems passing into a second childhood in its growing love of sweets.

Is this not a reasonable and wholesome love? They are pleasant to the eye and good for food; and how else can our food do us the

contemplated benefit than by being agreeable in its appearance and satisfactory in the results. Why point to teeth universally decayed as the result of sugar consumption. We know very well that our teeth depend upon our stomachs, and when the bulk of the nation lives a sedentary and unnatural life disordered stomachs must be, as they are, the natural product, and ruined teeth must be, as they are, the necessary result. We have no more reason to ascribe bad teeth to sugar than to the thousand other new elements we have introduced into our existence, and we are more inclined to consider it the effect of misplaced ambition, and the worry, excitement and irritation of modern life. We must here protest, too, against the too common blunder of ascribing to sugar, as the primary cause, whatever evils may arise from the indiscriminate and thoughtless use of all kinds of confections, often most injuriously coloured, and very frequently flavoured with noxious abominations. We might as well blame the blessed sun for the noxious exhalations that spring into life under its rays.

Sugar, therefore, has never been proved to be the author of any of the evils so commonly brought forward, although we do not doubt that the highly concentrated article now sold as refined sugar, divested of all its nitrogenous or mineral impurities, is much too rich for an ordinary stomach to consume alone in quantity with impunity. As well for a delicate man to attempt to imitate a Spaniard, and dine on a handful of roasted chestnuts with satisfaction and success. But the abuse of any article is no argument against its proper employment to the advantage of the majority.

As an ordinary source of carbon for the supply of this necessary portion of the diet of the nation, sugar has to compete against the cheapest productions of the land. Taking it merely as a form of starch, this latter is to be found in quantity ready for the use of the people, under the most varied conditions and in the most varied vegetable forms. In the potato we have it cheapest of all, and this plant in consequence has shown a still more marvellous rate of increase of production than even sugar itself. Except for the danger of disease it would, from its exceedingly prolific character, soon overwhelm all other sources of starch, which, however, it is

fortunately not allowed to do. Its starch can scarcely be distinguished from tapioca, and might conveniently be used in the same manner at the tables of the poor. Again, we have it in the cereals in unlimited quantity, although, perhaps, at a more expensive rate than in the potato. This, however, is not the case if we consider the flesh-formers that we procure from the cereals at the same time, as catmeal at 2½d. per lb. is quite as cheap a diet as potatoes at 1d. per lb., besides being more satisfactory to the diner. But taking the starch alone it is cheapest in the potato in an ordinary year, when they can be procured in unlimited quantity at ½d. per lb. Taking 15 per cent. as the quantity of starch in an average potato, and 50 per cent. as present in oatmeal, we have, at ½d. per lb., 75 per cent. of potato-starch for 2½d., the price of 50 per cent. of oatmeal-starch. On the other hand, 100 per cent. of sugar may be had for 3d. to 3½d., so that the equivalent in potato-starch would be about the same, and in oatmeal much dearer, say 5d. per lb.

From the above figures it is clear that simply for the supply of carbon in a palatable form for the table, foreign sugar can compete to-day with the very cheapest form of starch grown in this country, and excepting that the stomach is unable to receive such a rich freight with impunity, it would be undoubtedly the most satisfactory mode of supplying the breath-foods demanded by the system. This seems rather an extraordinary conclusion to arrive at, considering that this same sugar is a product of distant lands, and subjected to various expensive processes as well as requiring expensive carriage. But the rich tropical climate is so lavish of its wealth that it can still compete, notwithstanding all these disadvantages, with the most luxuriant productions of temperate climes.

We have not yet exhausted the subject, however, by considering the common cereals, as another tropical, and a semi-tropical product come into competition even as starch suppliers. These are maize and rice. The former grows so freely in inter-tropical America that with carriage added it can be purchased in England at 1d. per lb. in grain, and rice may be taken at the same price. But maize supplies much more starch per pound than oats, while the price

may be taken at a half, so that we have maize-starch (at 64 per cent.) at a lower price even than potato-starch, the sugar-equivalent being yet higher. Again, rice at even 2d. per lb. is cheaper as a starch supplying heat-producer than even maize, and indeed by far the cheapest of either native or foreign productions. For it has 82 per cent. of starch in its formation, and except in its finest qualities is quite as cheap as any of the cereals.

In using the word starch here we do not consider it in its character as purified from its surroundings, but in its natural position and condition, ready for transforming into sugar during the processes of mastication and digestion. In its more aristocratic form of sugar prepared for the luxurious necessities of civilized existence, it has no competitors among these humble suppliers of our vulgar wants. For this, we must call in the aid of the weed, cultivated by Marggraf, until a sufficient quantity of sugar had been developed for its practical employment. Certainly this sugar-beet-root is one of the greatest successes of agricultural skill during this century, and if it has now been successfully divested of 8 per cent. of its saccharine matter, will force our foreign cane-sugar growers to look to their laurels. In these days of never-tiring research it is only by continued progress that we can hold our places at all in any branch of human industry, much less advance therein, so that it is only by earnest endeavours to economise its production, increase its returns, and improve the processes of obtaining and refining it, that planters will be able to undersell this growth of temperate climes in its own chosen markets. To this end every planter must bring his experience to bear on the subject for the good of all, and all suggestions upon the subject of labour, in all its bearings, or fuel in its relation to the various localities, or the results attendant upon the employment of various manures, will be thankfully received. We continue to receive statistics of the value of the Concretor in increasing the yield of a given quantity of cane, and shall always be glad to hear the views of the different planters with regard to this valuable improvement, and others having the same end in view.

Do not let us be understood as sounding a note of alarm, we do not fear competition from any quarter, but in times of progress,

when "men are ever seeking something new," it is as well to be prepared for all eventualities; and there is no concealing the fact, that considering the yield of pure sugar from a certain quantity of cane, and the per centage known to exist therein, there is no lack of room for improvement in this branch of the trade. We, therefore, feel we are speaking for the trade when we seek for knowledge on every branch of the subject, that we may spread it forth again, and consequently appeal to all interested in the subject to compare notes, in hopes one day of being able to supply carbon to the nation as cheaply in foreign grown sugar as in the most prolific of home or foreign roots or cereals.

ADULTERATED SYRUPS.

The following article on "Adulterated Syrups," which we take from the *American Grocer*, and which is one of considerable interest, not only to buyers of syrups and sugars, but also to chemists. No one likes to be cheated, but how is it to be prevented? We buy cane sugar, we get grape sugar. It may be said that the one is as good as the other, still, to us, *if we discover the difference*, they are not the same. When we buy so much cane sugar, we buy so much sweetness, and we get sugar with a sweetness less than that we wanted. This is certainly a fraud—inasmuch as grape sugar has not, weight for weight, so much sweetness as cane sugar. We can in such a case only apply to the analytical chemist to keep us out of our difficulties, and in most cases it is only the wholesale buyers who can be helped in this manner, as the public cannot demand an analysis of the sugar they are buying before they do buy it, this power being, however, in the hands of the wholesale buyer.

The same that has been said of sugars can be said of syrups, these being merely sugar in another condition. We should be very glad if any of our readers would kindly send us different methods employed by them in testing the sugars they buy or sell.

It is only by spreading knowledge in this way that truth can be discovered. Any methods sent to us will be experimented upon and the results published in our pages.

ADULTERATED SYRUPS.

The *Herald of Health* gives the following account of grape sugar syrup, which is much made now :

"It has long been known to chemists that a variety of sugar could be manufactured from common starch, sawdust, cotton, or woody fibre of any kind, by treating it with sulphuric acid. The sugar thus produced is called grape sugar, and two and a half pounds are required to equal one of the cane sugar in sweetness. For some years this kind of sugar has been used in the manufacture of candy and of alcoholic liquors. It is also manufactured in Germany for commercial purposes, and more recently a number of manufactories have been established in this country for the purpose of imitating and adulterating the various forms of cane sugar. Several such establishments are located in New York and New Orleans, and one in Madison, Indiana. The greatest fraud seems to be in the article known as Golden Drip Syrup. This syrup is very superior in appearance, but often contains not the slightest trace of cane sugar, being made entirely from sawdust, paper rags, starch, and other similar trash, treated with sulphuric acid. This syrup can always be distinguished from the genuine by its reaction with an infusion of tannin. As tea leaves contain a large amount of tannin, a very convenient test is to put a small quantity of it into a little strong tea. If this syrup is of the kind described, the liquid will become black upon being stirred."

The test given above is not always a safe one for detecting the syrup made from starch or grape sugar. The best Sugar House syrup may give the same test. It is the iron in the syrup generally upon which the tannin in the tea acts and turns it black, and iron is frequently found in the very best syrups. Iron moulds are used in many refineries, and if these moulds are not kept very clean and well protected from direct contact with the syrup,

small quantities of iron, as rust, may find its way into the syrup. Starch or grape sugar syrup is not necessarily unhealthy or unclean. It certainly is used as an adulterant, and to the extent to which this is done, without explanation, all through the hands it passes until it reaches the consumer, it is a fraud, and that is the most that can be said of it. The name, Golden Drip Syrup, is applied by various dealers to as many different qualities of goods, and do not necessarily mean syrup made by the process alluded to. Such names are more a matter of fancy than of quality.

But there is a quality of this syrup not so carefully made as that produced directly from starch, which is decidedly injurious, and against the sale of which the trade should take a decided stand. It is made from Lignine, or the woody fibre that exists in cotton and hemp, and hence old rags and other refuse may be employed in its production. This substance is treated with sulphuric acid, and otherwise manipulated, until by a well understood chemical process, a syrup is produced that is skilfully used in mixing with other less objectionable syrup. We are glad to have the able assistance in this matter of the editor of the Chicago *Tribune*, who has recently published a very full and complete exposition of the subject, under the ominous title of "Death in the Pot," from which we make the following extracts:

"A few weeks ago the *American Grocer* called attention to the fact that certain parties are selling what purports to be sugar syrup, but is really an artificial product, obtained by the chemical action of sulphuric acid (oil of vitriol) upon some of several substances which consist principally of the essential material of wood fibre. There are reasons for believing that the manufacture and sale and consumption of this vile substitute for the genuine article is much more general than would be believed by any one who had not personally investigated the matter, It is probable that nearly 50 per cent. of the material, which, under the alluring names of golden syrup, silver drips, &c., enters largely into consumption at the breakfast table, especially in winter, is an artificial product of the chemist's skill and contains rank poison. The

writer has recently tested some samples of "very fine" syrup, served out to families, and found them to contain the oil of vitriol in dangerous quantity.

* * * * *

There can really be no more serious objection to the use of syrup made from starch than to the eating of crystallized sugar, which has been purified by passing through animal albumen; because the dangerous acid is all removed. The other stuff is so perilous to human health that those who manufacture it, and those who knowingly vend it, ought to be sent to the Penitentiary for life as conspirators against the bodily welfare of society. And the evil is so great that no one should dare to take the risk of selling this syrup. Fortunately, it is easy to bring it to the test. A small quantity of the muriate or nitrate of baryta, mixed with water, makes a clear solution. If to this be added a small quantity of sulphuric acid, a white precipitate is formed, which is insoluble in water. Tannin also gives a black precipitate; unless, perhaps, if the acid have been neutralized by albumen. If the syrup will stand these tests it may be sold and eaten with safety. If not, it should be thrown away, and its vendors prosecuted as modern Borgias."

The *Journal of Commerce* has the following bearing upon this subject:

"Some little excitement was created yesterday among the grocers by the report that certain sugar refiners were manufacturing a syrup very handsome in appearance, but containing a large proportion of lead, introduced (it was supposed) to clarify the syrup. Several of the principal refiners were visited and the subject investigated. Each and all of them denied using lead in any form for clarifying or in the other ways improving the quality of the syrup or sugar made by them. It was admitted by all that bi-acetate of lead was a good clarifier, but they believed it to be too dangerous a material to be used by the ordinary workmen employed in the refineries. One of the refiners said that he would consider it criminal to introduce it in his establishment, and he did not believe that it was used in any refinery in the United States. Its use

was advocated by the French some years ago, and was known as the chemical method of refining, originally practiced by Prof. Daniell, and afterwards by Dr. Scoffern. The method consisted in the use of a solution of basic acetate of lead for precipitating the coloring and foreign matter in the saccharine juice. The excess of lead was rendered insoluble by sulphurous acid gas, and the excess of the gas removed by boiling. This plan rendered the use of bone-black or animal charcoal unnecessary, but the treatment of the juice containing a poisonous salt of lead (sugar of lead) could be entrusted only to men of considerable chemical skill. In the refineries located in this part of the country, bone-black is used because it is cheaper, produces results equally as good, and is perfectly harmless in its action. Its use can be entrusted to workmen of average intelligence, and the material can be used many times if proper care is exercised in cleansing it. The refiners of New York and its vicinity are men of high character, and their denial of the use of lead in their productions should be sufficient to set the public mind completely at rest on that subject."

We cordially endorse all that is said above concerning our refiners. It is, however, a notorious fact that the sophistication of syrups is carried on *somewhere* very extensively, and that many such syrups find a market in New York. Our refiners, therefore, owe it to their own high character and standing not simply to disavow any connection with such disreputable practices, but to institute inquiries and publish the results in such manner as will effectually disabuse the public mind upon the subject.—*American Grocer.*

THE FERTILIZATION OF FARM LANDS.

By C. A. Goessmann, Ph.D.

(*Continued from page* 20.)

The great interest which the farmers of the State must feel to learn what they are buying, and whether they are getting the value of their money, has induced me to make myself somewhat familiar with the character of some of these fertilizers which enter

our markets. The samples have been taken from barrels bought in their respective depots in our vicinity, and had their proper brands, and, at the same, the required printed statements concerning their chemical composition. As the farmer does not propose to pay for anything but phosphoric acid, nitrogen (or ammonia), and potassa, I give my analytical results with particular reference to these substances. The valuation of these articles has been made in confirmity with the prices of late recognised by dealers and consumers in our section of the country. These prices are 16·25 cents for each pound of soluble phosphoric acid, 13·2 cents for every pound of reduced phosphoric acid, six cents for every pound of insoluble phosphoric acid, thirty cents for each pound of nitrogen, and eight cents for each pound of potassa. Reduced phosphoric acid is that portion which has apparently once been rendered soluble in water, but has become insoluble again in consequence of peculiar reactions which sometimes occur in the manufactured fertilizer. Its compound with lime is soluble in citrate of ammonia, and in a suitable condition for speedy absorption under the influence of the carbonic acid of the soil.

I.—Ammoniated Bone Superphosphate of Lime Manufactured by Russell Coe.

	Per cent.
Moisture and volatile matter	61·54
Non-volatile matter	38·46
Soluble phosphoric acid	10·55
Reduced ,, ,,	2·14
Insoluble ,, ,,	2·46
Nitrogen (=2·5 ammonia)	2·02

Valuation per ton of 2000 *pounds.*

			Dol.	c.
211·0	pounds	of soluble phosphoric acid	34	24
42·8	,,	of reduced ,, ,,	5	60
49·2	,,	of insoluble ,, ,,	2	95
40·4	,,	of nitrogen (50·0 lbs. of ammonia)	12	12
			54	91

II.—W. L. Bradley's XL Fertilizer.

	Per cent.
Moisture and volatile matter	52·11
Non-volatile matter	47·89
Soluble phosphoric acid	6·45
Reduced ,, ,,	2·83
Insoluble ,, ,,	3·60
Nitrogen (3·23 ammonia)	2·43

Valuation per ton of 2000 *pounds.*	Dol.	c.
129·0 pounds of soluble phosphoric acid	20	96
56·6 ,, of reduced ,, ,,	7	47
72·0 ,, of insoluble ,, ,,	4	32
48·6 ,, of nitrogen (64·6 ammonia)	14	58
	47	33

III.—Wilson's Ammoniated Superphosphate of Lime.

	Per cent.
Moisture and volatile matter	50·95
Non-volatile matter	49·05
Soluble phosphoric acid	6·65
Reduced ,, ,,	1·01
Insoluble ,, ,,	0·93
Nitrogen (3·42 ammonia)	2·82

Valuation per ton of 2000 *pounds.*	Dol.	c.
133·0 pounds of soluble phosphoric acid	21	51
20·2 ,, of reduced ,, ,,	2	66
18·6 ,, of insoluble ,, ,,	1	12
56·4 ,, of nitrogen (68·4 ammonia)	16	80
	42	09

IV.—Quinnipiac Soluble Nitrogenous Phosphate.

	Per cent.
Moisture and volatile matter	55·51
Non-volatile matter	44·49
Soluble phosphoric acid	5·50
Reduced ,, ,,	2·45
Insoluble ,, ,,	3·47
Nitrogen (3·14 ammonia)	2·59

Valuation per ton of 2000 *pounds.*

			Dol.	c.
110·0	pounds	of soluble phosphoric acid	19	87
49·0	,,	of reduced ,, ,, ...	6	67
79·4	,,	of insoluble ,, ,, ...	4	76
51·8	,,	of nitrogen (62·8 ammonia)	15	54
			46	74

V.—Fale's Fertilizer.

	Per cent.
Moisture and volatile matter	39·87
Non-volatile matter	60·13
Soluble phosphoric acid	1·50
Reduced ,, ,, ...	2·49
Insoluble ,, ,, ...	4·06
Nitrogen (3·23 ammonia)..	2·66

Valuation per ton of 2000 *pounds.*

			Dol.	c.
30·00	pounds	of soluble phosphoric acid	4	88
49·80	,,	of reduced ,, ,, ...	6	57
81·20	,,	of insoluble ,, ,, ...	4	87
53·20	,,	of nitrogen (64·6 ammonia)	15	96
			32	28

VI.—Guano (Guanape Islands).

Moisture and volatile matter	57·38	54·17	54·98
Non-volatile matter	42·62	45·83	45·02
Sand	10·94	12·47	13·10
Total phosphoric acid	11·59	12·08	11·25
Nitrogen (11·78 ammonia)..		9·70	
Potassa		2·02	

Valuation per ton of 2000 *pounds.*

			Dol.	c.
238·80	pounds	of phosphoric acid (at 12·64 cents per pound)	30	18
194·00	,,	of nitrogen (235·60 ammonia)	58	20
40·40	,,	of potassa	3	23
			91	61

I present these analytical results and valuations without any further comment. They tell plainly whether the amount asked for these fertilizers in the various sections of the State is a reasonable one. The guano, although inferior to the average Peruvian guano, is, it appears, still the cheapest ammoniated phosphate in our market. There are several important points in the fertilizer trade which require the serious attention of the farmer. The present condition of that trade leaves the farmer too much in the hands of the dealers, and places at the same time the honest dealer at a great disadvantage with his less scrupulous competitors in the business. To obviate this, it appears to be but right that certain provisions for the regulation of the trade in commercial fertilizers should be made. Every dealer in these articles should be obliged to accompany each package of his manure which enters the market with a distinct statement, giving the exact quantity of each ingredient which imparts a special commercial value to the fertilizer, and fraud in the manufacture should be a criminal offence, with a penalty proportionate to the damage done to the agricultural community. Allowances should be made, of course, concerning such alterations as time may cause, or as are unavoidably connected with the ordinary modes of manufacture on a large scale. In case judicious laws bearing on these questions should not be found expedient by those in authority, it would be well for the farmers to associate for their own protection, and to refuse to buy of any dealer who does not comply with their just demands. Differences arising between the dealer and the consumer could be decided by a chemical analysis. The chemist charged with the examination should be obliged to carry out the analysis according to some well-established mode, and to state his results in such a manner that every farmer could decide for himself whether he got the value of his money or not. The man who believes that he can judge correctly of the value of an artificial fertilizer by any casual examination, except as to its mechanical conditions, deceives himself. An abominable or peculiar odour is not necessarily an attribute of fertilizing substances. The pecuniary valuation of the various constituents of commercial manures should also be more

generally decided with reference to their fitness for immediate reaction, for a speedy effect is one of their principal recommendations. Their respective agricultural values, on account of their special character, are greatly dependent on the rapidity with which they render other latent plant-food in the soil active. The price of insoluble phosphoric acid is based on the price of bone-meal, and that of ammonia ought to be based on that of crude sulphate of ammonia. Bones and sulphate of ammonia are largely used in different branches of chemical industry. The outside demand controls their prices, and farmers cannot complain when they are asked to pay what everybody else has to pay. To apply, however, these prices indiscriminately to phosphoric acid and to nitrogen in every other form, may suit the dealer, yet cannot be considered a fair practice by the farmer. As far as the soluble phosphoric acid is concerned, it matters but little from what source it has been obtained; yet it is of considerable importance to know whether the insoluble phosphoric acid is present in the form of Peruvian guano, steamed bone-dust, fish guano, or poudrette—or in the form of coarse-ground bones, South Carolina, Baker's, Jarvis's, or Sombrero phosphate, or refuse boneblack from sugar refineries, or pulverized apatite. The substances first named are known to act as quickly, if not more so, than stable-manure, while those last named act much slower. The substances of the second group above mentioned ought not to be to any extent in their undecomposed state in any artificial concentrated phosphatic fertilizer. Their usefulness in their natural condition depends entirely on their minute mechanical division, and they ought to be furnished in a finely pulverized form, and each at its own commercial value. They should then be mixed with stable-manure, or a compost, where a steady supply of carbonic acid might prepare them advantageously for future assimilation. As it is quite troublesome to distinguish in any commercial compound fertilizer the peculiar source of the insoluble phosphoric acid, the safest practice for the farmer is not to buy so-called superphosphates which contain insoluble phosphoric acid beyond a few per cent., unless due allowance is made in the price.

In regard to the valuation of nitrogen, a distinction has been

made by chemists between actual and potential ammonia, meaning by actual ammonia that portion of nitrogen in a fertilizer which is already present in the soluble form, as some nitrate or ammonia compound. The name potential ammonia refers to that portion of the nitrogen which will be changed sooner or later, under suitable circumstances, into ammonia. The value of actual ammonia is, as already stated, best estimated from its cost in the form of crude commercial sulphate of ammonia. This compound is obtained in gas-works, and in connection with the destructive distillation of animal matter, as in the manufacture of boneblack. To estimate its value from its cost in guano, seems to be more objectionable, as its price in that case depends largely on the value we assign to the phosphoric acid present. The valuation of nitrogen, in the form of potential ammonia, should be somewhat restricted, as in the case of insoluble phosphoric acid. From the fact that a classification of substances, which are considered sources of potential ammonia, must be be necessarily somewhat arbitrary, it does not follow that we ought to discard entirely a proper lower value of potential ammonia as compared with actual ammonia, or that we ought not to discriminate between the various nitrogenous materials which may be used. Urates, blood, dried meat, steamed bone-meal, fish, guano, and poudrette, form ammonia with much readiness, excelling even stable-manure in this respect. On the other hand, refuse wool, leather, hair, horn-shavings, etc., are all much more slowly decomposed, and therefore require to be composted in a suitable mechanical form. These substances are, of course, valuable for agricultural purposes; but as a considerable period of time is required before their full benefit will be enjoyed, their price ought to be made with reference to the loss of interest on the investment. The practice of incorporating these substances into artificial fertilizers, without a previous proper disintegration, exposes the farmer not only to frequent disappointments in regard to his crops, but to serious pecuniary losses.

Having named some things concerning commercial manures, about which farmers and agricultural chemists ought to consult for the *general* good of agriculture, I take the liberty of advising all

persons to be cautious in indorsing this or that fertilizer. It should be enough for the buyer to certify that the dealer furnished him the substances which his bill specifies. To give him the entire credit of success, or to blame him in regard to the results obtained, is, as a general rule, unfair; for, as the various articles of plant-food act always in the same direction, and as they can only produce an increase of yield when they are needed, it is the good judgment of the farmer which deserves the credit in case his crops increase under his management, and at his own door rests the blame of his failures. Moreover, it not unfrequently takes years of systematic fertilization to show the beneficial influence of fertilizers upon exhausted lands. The best phosphates in the world will not improve the fertility of lands when potassa is wanting, and the richest ammonia compound will be without any effect in case a sufficient amount of ammonia is already present. The real money value of any fertilizer cannot be directly determined by the mere consideration of the results obtained at any particular time, and it is also evident that the condition in which a manure leaves the soil, after one crop has been raised, is a most important factor in deciding upon its entire agricultural worth.

II.

The Stassfurt Potash and Magnesia Fertilizers.

In a paper read before Massachusetts Board of Agriculture, in December, 1869, I alluded to the growing importance of the Stassfurt manure-salts. Numerous experiments, made by qualified parties in Germany, France, and England, leave at present no doubt about their great value as fertilizers. They have, also, of late been introduced into our markets, and as they supply a special want among our commercial concentrated fertilizers, and are thus destined to acquire considerable importance, it seems proper to make the farmers of the State more familiar with their character, and with the existing experimental results concerning their peculiar adaptation for agricultural purposes. These salts were first discovered at Stassfurt, Prussia, in connection with an extensive rock-salt deposit. In sinking a shaft to the depth of 1066 feet, a peculiar

layer of various saline compounds, 158 feet in thickness, was penetrated, which directly overlaid the rock-salt. This surface deposit seemed to consist of all the more soluble compounds, but slightly altered, of the oceanic waters, from which the entire deposit originated.* As a source of salt for ordinary domestic purposes, it was considered unfit, and, consequently, whatever had to be removed to get at the underlying rock-salt was drawn aside as worthless. The celebrated analytical chemist, H. Rose, subsequently called attention to this refuse mass as a source of potassa compound. The Government soon acted upon this suggestion, and caused, in 1860, sales at low rates, offering at the same time premiums to those parties who should succeed in inventing some suitable mode by which they might be changed into more valuable compounds for industrial purposes. The present extensive chemical industry at Stassfurt, and in its vicinity, is the outgrowth of that movement. The production of potassa amounted, in 1867, to 24,000,000 pounds, and the entire capacity of the Stassfurt mines, as far as explored at that time, promised to be from 100 to 120 millions of pounds per annum for 100 years to come. The influence of this new source of potash compounds on the general market of these articles may be inferred from the fact that, in 1863, the entire annual supply of potash compounds for industrial purposes consisted of 8,000,000 pounds of chloride of potassium, 40,400,000 pounds of nitrate of potassa, and 65,200,000 pounds of carbonate of potassa,†—in all, 113,600,000 pounds. Agriculturists were among the first to avail themselves of the cheap crude refuse salt for fertilizing purposes, yet they met, as a general rule, with but

* For details, see my paper "On Stassfurt Potash and Magnesia Salts, etc."

† The carbonate of potassa was obtained from the following sources:—

	Pounds.
Russia	18,200,000
North America	13,500,000
Hungary	10,300,000
From refuse material in the best sugar manufactories of Europe	23,200,000
	65,200,000

little success in their experiments. A comparison of the results of chemical analyses soon established the fact that the material used in the various experiments must have differed widely in its composition. This difference in composition found its explanation in the peculiar arrangement of the various salts in nature. They occurred in successive layers, and their quality depended entirely on the locality whence they had been taken. The following figures convey some idea of the variations noticed in the composition of the crude Stassfurt manure-salt used in many of the early experiments (Heiden):—

	Per cent.
Chloride of magnesium	from 12·20 to 31·19
,, sodium	,, 2·69 ,, 57·20
,, potassium	,, 0·00 ,, 14·49
Sulphate of soda	,, 1·90 ,, 17·21
,, potassa	,, 2·00 ,, 19·21
,, lime	,, 0·00 ,, 19·10
Carbonate of lime	,, 0·00 ,, 4·40
Borate of magnesia	,, 0·00 ,, 4·01

These analytical results render it quite obvious how little reliance could be placed on experimental results obtained by the use of a substance liable to vary so widely in its constituents, as well as in their relative percentage. Farmers, consequently, discontinued their use, and thereby compelled the dealers in these fertilizers to exert themselves to produce a more reliable material. The consequence has been, that at present there is scarcely a Stassfurt potassa fertilizer in the market which is not the result of some process of concentration. As a good illustration of what is at present offered for sale at Stassfurt for agricultural purposes, we may refer to a late price-list of one of the largest manufacturing companies of these fertilizers. One of the managers of this company is the most successful inventor of new modes of manufacture in this branch of industry, Dr. Grüneberg. The following price-list was published January, 1872, and the price is based upon a value of seventy-two cents, gold, for one Prussian thaler at Stassfurt, the salt being sold in bulk:—

	Percentage of oxide of potassium.	Price per 100 lbs. of the fertilizer.	Price of one lb. of oxide potassium.
		$ c.	$ c.
1. Potash fertilizer, ground, containing from 16 to 22 per cent. of sulphate of potassa, with more or less of chloride of sodium, to suit the customer	9·11	0 36	0 3·5
2. Concentrated potash fertilizer, containing	25·00	1 26	0 5·0
3. Sulphate of potassa and magnezia fertilizer (or artificial kainite), containing from 28 to 30 per cent. of sulphate of potassa	15·18	0 60	0 4·0
4. Concentrated sulphate of potassa, equal to from 78 to 80 per cent.	43·44	3 36	0 7·8
5. Concentrated chloride of potassium (No. 5), containing 80 to 85 per cent.	50·53	2 64	0 5·0
6. Sulphate of potassa and magnesium, with 52 to 56 per cent. of sulphate of potassa and 30 to 38 per cent. of sulphate of magnesia.....	28·3	2 64	0 7·8
7. Sulphate of magnesia, equal to 60 per cent. of sulphate of magnesia.....	0·0	0 36	0 0·0
8. Sulphate of potassa (about 11 per cent.) with a large percentage of magnesia for scattering over stable-manure and compost heaps.....	5·8	0 24	0 4·1

We learn from the foregoing figures that the oxide of potassium costs less per pound in the lower grades (1, 3, 8) of these compounds than in the higher ones (2, 4, 6), and also that it costs less in the highest grades of chloride of potassium than in that of the sulphate of potassa (4, 5). The cheapness of the lower grades is considerably reduced by an increase of freights for less valuable articles;—as soon as the freight for one hundred pounds of oxide of potassium exceeds about sixty cents, gold, the higher grades become cheaper material for use. With us, considering the cost of freight, the higher grades are decidedly preferable. I have made an analysis of various samples of Stassfurt fertilizers. The following statements may convey some idea of what has been offered for sale in our own markets during the past few years:—

	Per cent.
1. Concentrated sulphate of potassa, represented to contain 90 per cent., I found	87·72
2. Chloride of potassium, represented at 90 per cent., I found	89·02

	Per cent.
3. Refined sulphate of potassa and magnesia :—	
Sulphate of potassa	43·3
,, of magnesia	33·1
,, of lime	2·2
4. Concentrated sulphate of potassa, equal to 22·87 oxide of potassium	42·0
5. Calcined (rough ground) sulphate of potassa and magnesia :—	
Sulphate of potassa	19·90
,, of magnesia	17·50
Basic chloride of magnesium	4·60
Sulphate of lime	4·20
6. Artificial kainite :—	
Sulphate of potassa	27·60
,, of magnesia	18·18
,, of lime	5·20
Chloride of sodium ,, of magnesium }	not determined
7. Calcined native sulphate of magnesia (=kieserite):	
Sulphuric acid	52·29
Magnesia	25·31
Lime	6·59
8. Native sulphate of magnesia (=kieserite):	
Sulphuric acid	39·98
Magnesia	17·86
Lime	4·86

The unsatisfactory results at first obtained with the crude salts discouraged, as before stated, their consumption in general agricultural operations, yet it did not affect the opinion of those parties who believed in the fair prospect and great importance of an additional abundant and cheap source of potash compounds for agricultural purposes. They continued experimenting under more defined and thus more favourable circumstances. The question before scientific investigators was not whether a potash fertilizer would be useful for agricultural purposes, for there was scarcely an ordi-

nary rotation of crops on record in which the demand for potassa did not exceed that of any other plant-food, phosphoric acid frequently not excepted,* provided stock-fattening is not a prominent feature of the agricultural system adopted. Some of the most important commercial farm-crops, as potatoes, beet-roots, hops, tobacco, corn, etc., are known to require a large quanity of potash; while the most prominent potassa-containing rock, as potassa felspar, etc., disintegrate very slowly, and thus can furnish the potassa but sparingly. A few detailed statements may convey some definite idea regarding the consumption of potassa by most agricultural crops (Birnbaum):—

		Pounds.
Grain crop abstract per acre, ...	about	23·70
Meadows and pastures, ...	,,	56·88
Most garden vegetables and hoed crops, ...	,,	111·60
Clover and other fodder crops, ...	,,	63·20
Commercial plants, ...	,,	79·00
Grape vines	,,	63·20

Cordel asserts that sugar-beets in Austria abstract annually from the soil 17,300,000 pounds of potassa, in France about twice as much, and in the German Confederation 38,900,000 pounds, and that potatoes abstract in Old Prussia, without counting stems and leaves, 84,000,000 pounds from the lands under cultivation with that crop.

Taking the utmost economy for granted, there is scarcely any reason to doubt that in very many instances an application of potash fertilizer will be as beneficial as phosphatic fertilizers have proved. Farmers who have been in the habit of suffering their liquid manure to waste have particular reason to try potash fertilizers upon their lands. Numerous experiments manifestly show that the majority of farm lands, which have been for any length of time

* Prof. Birnbaum, in calculating the average consumption of soil constituents of fourteen different systems of rotation, allowing the usual complement of live-stock, finds that for a medium production every acre requires an additional annual supply of 17·4 pounds of potassa; 6·4 pounds magnesia, 11·0 pounds of lime, 14·2 pounds of phosphoric acid, in case stable-manures is the fertilizer.

under cultivation, are in such a state of exhaustion that an addition of phosphoric acid and potassa produces larger crops than either one of these fertilizers alone, and that potassa, phoshoric acid, and some suitable nitrogen compound will act still better than either two of them alone. It is for this reason that those who have no clear idea about the specific action of each crop upon the soil usually get along better with compound manures—as stable-manure, ashes, and oil-cake—than with special fertilizers; yet they rarely obtain a maximum yield, nor can they expect to engage successfully in the production of special crops of a superior character. These compound manures acquire, in fact, a particular importance, when we consider their composition with reference to the crop to be raised by their aid. The idea that we can produce large crops of all kinds of plants by adding a little of everything finds no support in the past experience of high or special farming. The farmer, who wishes to cultivate his lands most profitably, must qualify himself to comply with the special demands of his crops.

The main point in regard to the potash fertilizers, which required exact investigation, was to learn, by actual experiment, in what particular form the Stassfurt potash compounds would act best—whether as chloride or as sulphate—and what peculiar effect those compounds exert which accompany the potassa in either of these two forms. The results thus far obtained may be summed up as follows: the sulphate of potassa is unanimously indorsed as the safest potash compound, without regard to the kind of crop, particularly as far as the quality of any product is concerned. According to Stöckhardt, it increases the percentage of starch in potatoes. Karmrodt and Stohmann found that it increased the sugar in the sugar-beet. Schlossing and Nessler noticed that it counteracted best, in common with nitrate of potassa, the tendency of tobacco to char, and thus to smell offensively, thereby rendering it better adapted for smoking, and increasing thus its commercial value. Upon wet lands alone is its use decidedly uprofitable. Even Sir Humphry Davy noticed this fact. The chloride of potassium has not received such general commendation, and its use as a fertilizer for potatoes and tobacco has been decidedly discouraged, for it acts

upon these crops, more to increase the quantity than to improve the quality. It is, however, highly recommended for meadow and pasture lands, for all kinds of forage crops and grain crops, particularly when applied in connection with superphosphates. The chloride of potassium is also specially suited for use upon wet lands, and in case of very retentive, heavy soil. The efficiency of any potash fertilizer can, of course, show itself only when an additional supply is needed; yet even in case of deficiency in the soil, its effect may be greatly influenced by the condition of the same. If it is too retentive, the circulation of the salt will be limited; and, if not retentive enough, it will descend too quickly to the subsoil.

As long as the matter of absorption was but little understood, many observations with potash fertilizers could be scarcely reconciled with each other, and their merits remained doubtful. The peculiar absorptive properties of a good agricultural soil, which Way and Thompson first noticed, has been more studied, and additional facts have been established within later years, which enable us to control better the physical condition of the soil regarding the distribution of an article of plant-food like potassa, phosphoric acid, etc. We have learned that the property of absorbing these substances belongs mainly to the fine, clayish silt in the soil, and to a sufficient amount of humus well distributed throughout the entire earthly material under agricultural treatment. As both these conditions of the soil are the natural consequence of a proper cultivation, we find it not surprising that the improved portion of the same kind of soil possesses higher absorptive powers than the uncultivated one. The phenomenon of absorption appears to be but another name for replacement, since it has been noticed that absorption of potassa takes place only when compounds of soda, lime, and magnesia are present, while a corresponding amount of the latter is always set free, and passes into the subsoil waters. In case these substances are wanting, or are only present in a small quantity, or in a form not suitable for exchange, the absorption does not occur, and consequently the action of the fertilizer becomes uncertain. . The discovery of chemical means to aid in the distribution of phosphoric acid by Liebig, has been of late followed by

the recognition of means to promote the distribution of potassa throughout the entire bulk of the soil under cultivation. Foremost among these means are chloride of sodium (Frank) and sulphate of magnesia (Pincus). The beneficial effect of common salt as a fertilizer is doubtless often the result of this fact.

Some of these Stassfurt fertilizers deserve particular attention on account of a large percentage of sulphate of magnesia, and, in some instances, more or less of chloride of magnesium. The latter compound is, even in small quantities, directly hurtful to vegetation, and no fertilizer should contain it to any extent. Calcined potash compounds are usually free from it. Magnesia compounds, as a general rule, are in their isolated condition objectionable for fertilization, yet in presence of potassa or soda compounds they seem to be harmless. The sulphate of magnesia has for two reasons acquired considerable value in agricultural operations—it may be used as an absorber of ammonia and phosphoric acid, and aid in the distribution of potassa in the soil. As a means for the distribution of potassa, it is known to exceed every other which has been applied for that purpose. Fertilizer No. 6, consisting of 52-56 per cent. of sulphate of potassa and 30-38 per cent. of sulphate of magnesia, enjoys a particular reputation on account of its superior fitness to cure clover-sick and beet-sick lands, the potassa passing rapidly to the lower strata of soil, and coming thus in direct contact with the roots of these plants. The sulphate of magnesia may be used like gypsum, and, if scattered over stable-manure, or composted with it, absorbs ammonia, and combines with the soluble phosphoric acid, while, on account of its greater solubility, it exceeds gypsum in efficiency. As magnesia is one of the most essential articles of plant-food, it is natural that a direct incorporation of it in the main fertilizer may produce beneficial results. The peculiar saline character of these Stassfurt fertilizers renders it advisable to apply them with some special precaution. In their isolated state, they injure the roots with which they come in direct contact, and they are, therefore, best either scattered daily in small quantities, or composted. These modes of application are undoubtedly most advisable in general farming. In case they are to

be used for special crops for commercial purposes, they ought to be mixed thoroughly with three or four times their weight of muck or loam, and then carefully used with reference to the object in view. The best time for application is late in fall or early in spring, to allow their suitable distribution in the soil. In case of a loose, sandy, or gravelly soil, where spring manuring pays best on account of a low degree of absorption, it is best to incorporate them but a short time before planting. Their continued systematic use is only to be recommended upon well-drained lands.—10*th Annual Report Mass. Ag. Col.*

SUGAR MACHINERY.

From "*Iron.*"

(*Continued from page* 40).

When the manufacture of sugar is carried on upon the most extensive scale, and economical difficulties as to fuel may be disregarded, the apparatus known as Fryer's Affusor may be employed as a supplementary adjunct to the cane-mill, for the treatment of the crushed cane, so as to extract the remaining juice, as far as possible, by means of repeated washing or maceration in warm water. This consist of a series of rollers within a tank, set in an upper and lower row, all the points of contact being under water except the last one or two. The crushed cane is passed through in one direction, and the stream of water in the opposite, carrying with it the bulk of the remaining saccharine matter in solution.

The next process is the defecation of the expressed juice taken from the cistern into which it has been pumped up. The pans in which this is effected are called clarifiers or defecators, and may be acted on by direct heat, having independent furnaces, with flues and dampers, for the due regulation and control of the heat. But on the most improved system these clarifiers are ranged side by side on a raised platform, from three to twenty-four in number, and heated by steam at 40 to 45 lbs. pressure. They are formed

of a double hemispherical bottom, constituting the steam chamber, surmounted by a cylindrical vertical side, which, as well as the inner bottom, is formed of copper planished and burnished, the outer bottom being generally of cast iron. Suitable steam feed pipes are provided, and the bottom of the pan is fitted with a two-way cock, whereby the sediment and scum are separately conveyed through gutters to the scum-cistern, while the intermediate stream of clarified juice is conducted to the evaporating apparatus direct, or to the bag-filters, filter presses, or charcoal filters, to which farther reference will be made.

There is, however, another variety of clarifier in common use, consisting of a rectangular vessel containing a peculiar series of horizontal bent copper tubes attached to a cast iron head or cross-piece, with trunnions carried and revolving in juice-tight bearings in the sides of the clarifier, whereby the entire nest of tubes can be raised out of the liquid: the tubes are connected throughout for the passage and circulation of the exhaust steam, which is the heating medium; but it is also customary to provide connections for high-pressure steam, for boiling at the end of the defecating process.

Upon the most improved systems the clarified juice is now conveyed to the Patent Concretor, the invention of Mr. A Fryer, of Manchester, of which we give detailed plan, elevations, and section. The object of this apparatus is to concentrate the defecated and clarified juice, by evaporation, in the quickest possible manner independent of manual labour, and with the least possible change in its condition or colour, so as either to convert it into a mass which sets hard on cooling, suitable for the refiner's operations; or into a thick syrup for farther treatment in the vacuum-pan, as may be desired. It consists mainly of two parts, the first being a series of shallow trays, placed on an incline, end to end with suitable connections, and divided transversely by ribs or ledges running from one side nearly to the other, alternately, so as to baffle the flow of the clarified juice, and compel it to follow a serpentine path in its descent. Under the upper end of the inclined trays is located the furnace, and the flue runs along under-

neath the trays to the lower end, a distance of about 50 feet, where it passes into an air-heater and thence into a chimney outlet: thus the combustion products are first employed to boil the juice, and then to heat the air, for use in the second part of the Concretor, before finally escaping. The first three trays are made of wrought iron, as the heat of the furnace would crack cast iron plates, and they are also laid on a less slope than the remainder, so that the inflowing juice may be thoroughly exposed to the evaporative effects of the heat. The lower trays are of cast iron on a greater incline, and the juice is therefore enabled to maintain a duly-proportioned rate of flow, notwithstanding its continually increasing condensation and concentration; and moreover, as will be understood, the maximum heat of the furnace acts upon the fluid of least consistency, and as the syrup becomes more dense, so does the heat applied become less intense. The channel thus traversed by the thickening syrup is about 400 feet in length, and the resulting concentration is about from a density of 10 to about 30° Baumé, obtained during a period of about ten minutes, taken by the juice to traverse the trays.

From the lower end of the trays the concentrated syrup flows into a tank, and thence into the second part of the apparatus, a revolving cylinder containing a number of volute frames, formed of scroll-shaped wrought iron plates helically fixed to radial arms. The cylinder is caused to rotate by a small independent steam-engine, and as the cylinder revolves the syrup flows over both sides of the iron volutes, exposing a very large fluid surface to the evaporating action of the heated air from the air-heater, which is drawn through at the same by the action of a blast-fan simultaneously operated by the engine. About twenty minutes is occupied by the passage of the syrup through the cylinder, whence it issues at a temperature of about 195° to 200° Fahrenheit, and of such a degree of consistency as to solidify upon cooling into a mass of concrete sugar, neither amorphous nor perfectly crystalline, but comprising all the molasses in a solid form, not liable to drain out from the mass, and therefore adapted and ready for immediate shipment; it being part of the inventors' contention that

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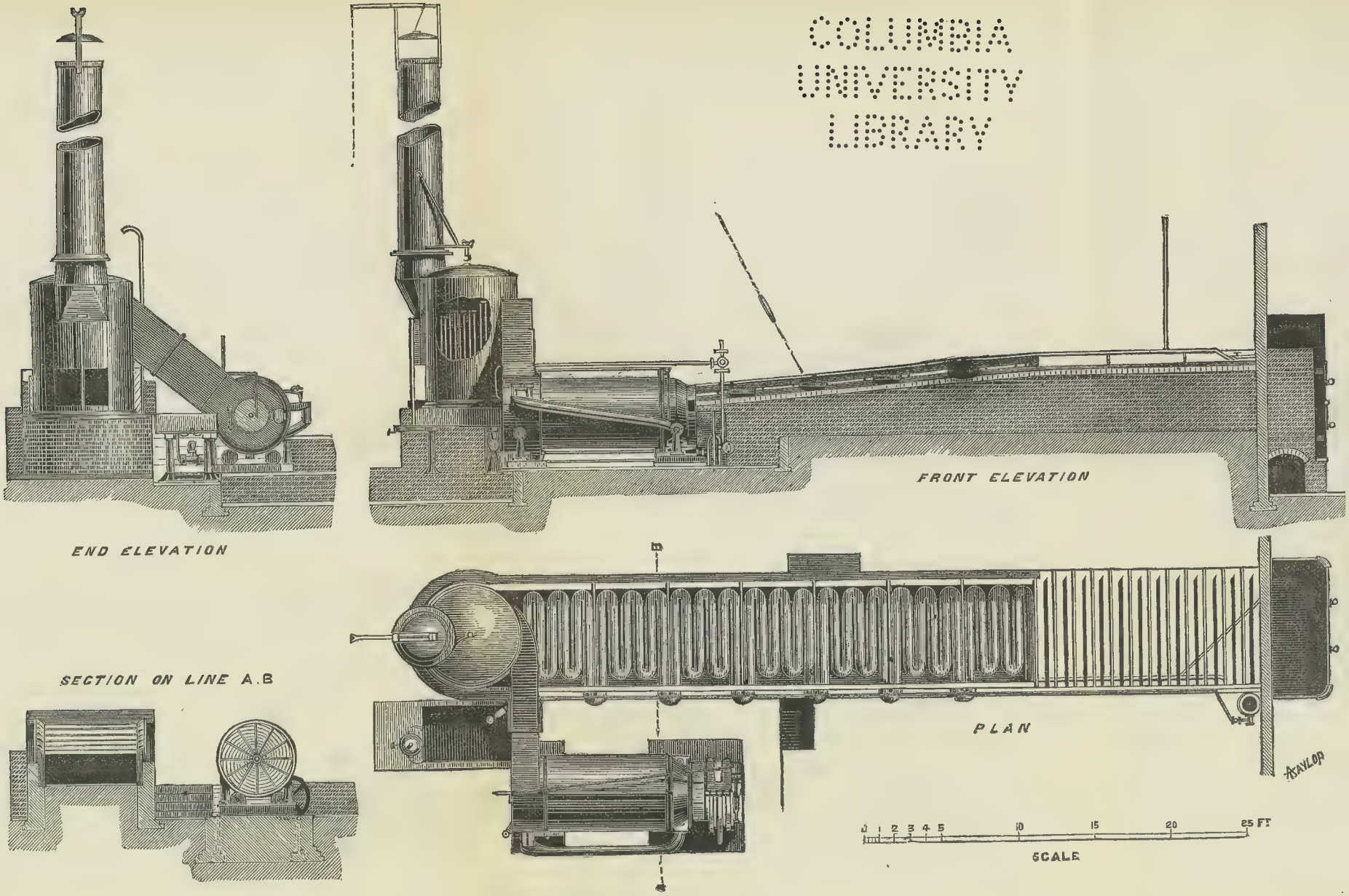
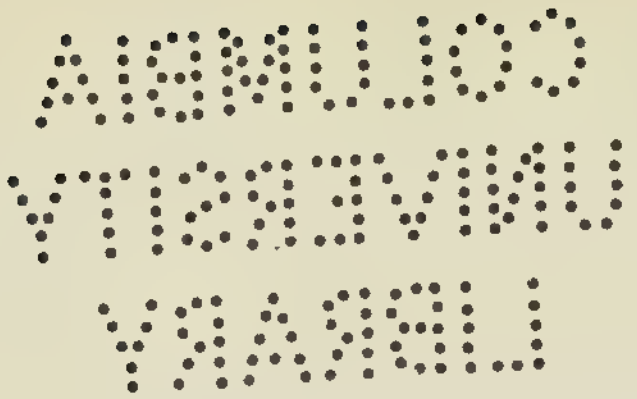


Fig. 4.—FRYER'S PATENT CONCRETOR.



the planter should rather work for the refiner than make the finished sugars himself, as the delicate operations of refining can be carried out better and more economically in Europe than in the tropics. This, however, is a phase of the question into which we need scarcely enter; suffice it to say that the Concretor is capable of effecting the rapid concentration of cane-juice or saccharine solutions, without any perceptible injury or deterioration in quality, if worked with due care and attention; the temperature is never excessive in any part of the apparatus, and it is most moderate where the syrup is thickest and most susceptible of damage; and the exposure to heat is so brief, not exceeding half-an-hour, that there is not time for the regular formation of perfect crystals.

When, however, it is desired to complete the manufacture of sugar to its last stage, the crystallized form, other appliances and processes are employed. The old fashioned apparatus was the Jamaica Train, consisting of a series of hemispherical open copper-vessels, diminishing gradually in size, and heated by a furnace placed under the smallest, with a flue passing along under the whole series. The evaporation and concentration of the juice began in the largest pan, the farthest away from the furnace, and ended at what is technically called "proof," in the smallest pan, the "tayche," the syrup, as it became denser, being ladled successively from one pan to the other. This is an objectionable and wasteful method, on account of the length of the process and the high temperatures to which the syrup is exposed; it is, nevertheless, even yet too generally used. At the "striking point" or proof, the sugar is removed to the coolers, shallow pans some 18 inches deep, where it remains some 24 hours, before being taken to be packed in hogsheads in which it is left for several weeks to allow the molasses to drain out of the mass.

But, for all fine qualities of sugar, the boiling of the syrup in the most modern and improved process is effected in the vacuum pan, at a very low temperature, and the removal of the molasses is effected in a centrifugal machine. Before describing these apparatus and appliances, however, we may note that various intermediate improvements on the simple working of the Jamaica Train have

been introduced and practised with advantage; firstly in the shape of the vessels, which are made rectangular and flat bottomed, in lieu of hemispherical—excepting the "tayche"—thus affording a greater extent of heating surface, in proportion to their contents. In the next place, another modification relates to heating all the pans by steam, with a jacket and coils, similar to the clarifiers; the best known and most efficient of these is the Aspinall pan, in which the juice is boiled by steam admitted to a copper case with a number of parallel tubes allowing the syrup to flow freely through. Another arrangement employs the Jamaica Train for the evaporation to a density of about 25 or 30° Baumé, the concentration being completed in the open air in a low temperature pan, such as Gadesden's. The best pan of this class, however, is the Wetzel pan, which, as made by Messrs. Manlove, Alliott, and Co., consists of a series of steam tubes, made of copper, and coiled spirally round between two hollow copper discs or dishes, in the form of a hollow cylinder; this is fitted with trunnions and gearing, whereby it is made to rotate, within a shallow semi-cylindrical pan in which the concentrated syrup is placed. Thus the surface of syrup exposed to the joint action of steam-heat and open-air evaporation is very large, and the evaporation is rapid while the temperature is kept very low.

For high-class sugar there is nothing comparable to the Vacuum Pan, wherein the boiling of the syrup at low temperature enables the concentration to be made with very little deterioration, and the process to be prolonged sufficiently for the generation of large crystals of good colour and composition. The Vacuum Pan consists of a large closed spherical copper vessel fitted with a steam-jacket and copper steam-coil to the lower half, and connected with an injection condenser and air-pump. The copper pans vary somewhat in shape, according to the object in view, some being perfectly spherical, others spheroidal in form with flat shallow bottoms, others oval and greater in depth than in horizontal diameter. The steam jacket is of cast iron, and together with the worm is provided with suitable steam-pipes, cocks, and connections. The vacuum is generated and maintained by means of the air-pump;

on the upper portion of the pan is a chamber or dome and pipe leading to the condenser, where the vapour from the boiling liquid is condensed; the vacuum pan is fitted with a great many appliances necessary to its efficient working, namely, a meter by which the quantity of syrup admitted may be recorded and known; sight-glasses, for inspection of the contents; a proof-stick for extracting a sample for examination, without destruction of the vacuum; a tell-tale to intercept any liquor carried over with the vapour into the condenser; a cup for the introduction of oil or butter to still the boiling liquid, if required; vacuum gauge, discharge-valve, gauge-glasses, and manhole. The whole apparatus is generally erected on an independent framing and platform.

Instead of performing the whole operation in one vessel, a system is some time adopted, known as the "Triple-effet" for economy in fuel and in condensing water. This consists of a series of vessels of various kinds; a measure and a steam receiver communicate with the first pan, in which there is only a slight vacuum, and which is heated by exhaust steam at 5 lbs. or 6 lbs. pressure; the vapour and steam for the first pan pass into an intermediate receiver and thence into the second pan, which acts as a condenser for the first, where the vacuum is more complete, and the boiling takes place at a lower temperature; from the second pan the steam and vapour pass through a receiver into the third pan, where they are again condensed; here the vacuum is made perfect, and maintained by an air-pump, and the steam finally removed by a separate condenser. The third pan is also connected by a pipe with an apparatus called a montejus, an iron vessel for elevating the syrup, by steam pressure, for final concentration in a separate vacuum pan. This system, however, in all save economy of fuel and condensing water, is not so good as the single vacuum pan; and, as shown in our engraving, the Concretor may be advantageously substituted for it.

ECONOMY OF FUEL.

(*Continued from page* 12.)

CHAPTER THIRD.

Attempts made to Lessen the Losses above indicated.

Section XI.

This question of the economy of fuel has tried many; indeed, the waste of coal that we make is in reality a fine, a contribution that we must all pay, for it weighs on the price of all manufactured articles. It is, then, absolutely true to say that the subject treated here is a social question of the highest consequence.

The essays attempted have been numerous and varied. Some have approached the desired end; often intelligently conceived, they have partly failed because they did not rest on true theoretical principles.

Most inventors have attempted this single result, *smoke consumption*, so that almost all the apparatus bear above all the name of *smoke-consumers*.

Now, the disappearance of the smoke produces a really considerable economical result, on condition, at the same time, that it is not obtained by leading an excess of air into the gases, but what precedes shows that the principal enemy was the natural draught, in one word the presence of a chimney. Nowhere do I find a trace of an invention having for result its disappearance. But another cause of important loss still due to the use of the chimney lies in the fact of a combustion, under varying volume, of the burnt gases, and the system developed theoretically and practically hereafter, having for object and result the total suppression of the chimney, and the constancy of volume of the burnt gases, is the true solution of the problem which I here discuss.

I will throw a rapid glance over the various apparatus proposed these few years back. We may class them thus:—

1. Furnaces with moveable grates.
2. Apparatus with an extra introduction of cold or warm air.

3. Furnaces, called smoke-consumers, with steam forced on the flame, on the fuel, or in the chimney.

4. At length, the various furnaces called *Gas*.

Those of the first list are more or less complicated mechanical apparatus, now abundant.

Those apparatus of the second series remedy nothing. In general it is not in the quantity of air where a furnace fails, it is only that its mingling with the combustion gases does not take place. Then, all apparatus which confines itself to leading in an excess of air only exaggerates the first loss.

The apparatus of the third series go a little better to the root of the matter. They attempt the mingling of the gaseous matters; but the steam injected absorbs heat, by its partial decomposition, without being able to restore it by its reconstitution, and so increases the quantity of sensible heat lost by the chimney, and in fine costs very dear, to produce almost no effect.

The smoke-consumer, Thierry, which is the principal of these apparatus, promises a saving of 10 per cent., due to smoke consumption; and if we make a calculation based on the figures of this inventor himself, in his prospectus, we find a waste of fresh steam of 8 per cent. which eats up the promised economy.

SECTION XII.

At length come *gas* furnaces.

The application of the principle of the previous change of the fuel into gases goes back very far.

The first industrial exhibition of this kind of heating appears to be due in France to MM. Thomas Laurens and Ebelmen. Since the works of this last-mentioned *savant*, we may say no progress of importance has been made, although this question has since been taken up under various forms.

The principal modern attempt that has succeeded within certain limits is that of M. Siemens. I will not attempt to judge of the merit and novelty of the invention; I will only speak of its principle and of its results.

In this proceeding the gas generator is not muffled; the heat produced by the transformation of carbon into oxide is wholly lost,

for it is impossible to recover the smallest part by the decomposition of a certain quantity of steam thrown on the furnace. The principle of the apparatus is also opposed to the utilisation of the sensible heat of the produced gases, since the draught demands that they arrive sensibly cold at the regenerator. Now, if we make the calculation, we find that the heat disengaged by this first transformation of the carbon is equal to 160,745 heat units, or a loss of 20 per cent.

Let us add to this first loss that of all the cinders which are wholly deposited in the pipes, and if we allow that their selling price scarcely compensates the loss of money, and inconvenience, caused by the necessity for frequent removal, we reach by this key a second loss amounting to

$$11{,}858 \times 5 = 59{,}290 \text{ heat units.}$$

or 7·4 per cent.

The radiation from the furnace cannot be utilised practically for the same reason that has caused the first loss. Still further, the radiation is here greater than in all other systems. M. Kraus, in his study of this method of heating, after a series of laborious calculations, finds the value of the loss caused by radiation to be:

27,750 heat units, or practically 3·5 per cent.

The Siemen's generator having a natural draft, it is per force limited by the thickness of the fuel that the current of air must pass, and this thickness is almost always insufficient for completely saturating with natural oxygen. The proportion of carbonic acid becomes at times very great when it collects and leaves interstices in the bed of gas coal.

By means of the forced current of air, on the contrary, one can make the thickness of the bed as strong as may be necessary to change the carbonic acid entirely into carbonic oxide. The double draught used in these furnaces makes them very delicate to manage, and subject to the caprices of the wind.

The first draught flowing back drives the gases into the furnace by the "cooling tub," then the second blowing the smokes throws them again into the air.

This first draft causes a loss of heat, which forms part of that

previously formed, equal to 20 per cent. As to the second, it is determined by the temperature of the smokes on their arrival in the chimney. M. Kraus says they escape at about 200°. This number is, to my mind, a minimum. I have established several times a much higher temperature; at the same time, in adopting this, we find a new loss equal to 10 per cent.

If now we consider the smoke consumption of this apparatus, we understand that it is far from being complete. I have seen chimneys of Siemen's furnaces smoke as much as those of an ordinary furnace. The reason of it is that the manner of measuring out the air and mixing it with the gases are very imperfect. No arrangement forces them into close contact.

I believe myself very partial in taking only 50 per cent. as the loss due to incomplete burning.

In fine, the loss of heat used in vaporising 48 kilos. of water exists here in its entirety, say 3·6 per cent.

I will not stop over the assertions of some writers as to the unlimited heat that, according to them, this procedure is capable of reaching. A very simple calculation shows clearly what temperature, still much narrower, it cannot pass.

Without insisting further upon various other inconveniences inherent to this system, I will sum up the conditions of its working, finding the following losses, of necessity:—

1st. Change from carbon into oxide	20·0
2nd. Non-utilisation of cinders	7·4
3rd. Loss due to second draught	10·0
4th. Incomplete coal consumption	5·0
5th. Radiation	3·5
6th. Vaporising 48 kilos. of water	3·6
	49·5

Say about 50 per cent. Under these circumstances, it offers about 20 per cent. advantage over ordinary heating; and in effect that is the figure various directors of manufactories have acknowledged to me in certain cases.

I will not press further on your consideration the various other

attempts that have been made. If they have not succeeded in general it is as I have said, because they have not considered the question in its entirety, because they have not attacked the principal enemy, which is the free expansion of the burnt gases, and of which the ally is the chimney.

The new system I am about to develop resolves, I believe, completely the two difficulties I have pointed out, consisting in incomplete combustion, and the free expansion of the burnt gases.

TESTING SUGAR SOLUTIONS BY MEANS OF AREOMETERS AND THE OPTICAL SACCHAROMETER.

By P. Casamajor.

(*Continued from page* 30.)

Part Third.

Estimation of Pure Sugar in the Dry Substance of a Solution.

If in a sugar solution we place a Balling's areometer, it wil indicate the number of grammes of impure sugar in 100 grammes of the solution. If we wish to know the amount of impure sugar in 100 cubic centimetres of the solution, we must multiply the indication of the arcometer by the specific gravity of the solution, because the number of grammes in 100 c. c. of the solution is obtained by multiplying this volume by the specific gravity, water being 1. Following the notation we have used all along, and calling the degree Balling D and the specific gravity P, the quantity of impure sugar in 100 cubic centimetres is expressed by $D \times P$.

To find the expression of the quantity of pure sugar in 100 c. c. of the same solution, we make use of the optical saccharometer. If this is one of Duboscq's intruments, we must bear in mind that 100 per cent. represents 16·35 grammes of pure sugar in 100 c. c., or that 1 per cent. represents 0·1635 gramme in 100 c. c. The quantity of pure sugar in 100 c. c. of a solution is then obtained by multiplying the indication of the saccharometer S by 0·1635.

The percentage of pure sugar in the dry substance is then expressed by

$$\frac{S \times 0{\cdot}1635}{D \times P}$$

The quantity $D \times P$ is easily obtained, as to every degree Balling corresponds a determined specific gravity, to be found in tables or by the formula already given:

$$P = \frac{259{\cdot}3}{259{\cdot}3 - D}$$

from which

$$D \times P = \frac{259{\cdot}3 \times D}{259{\cdot}3 - D}$$

the formula

$$\frac{S \times 0{\cdot}1635}{D \times P}$$

may be written

$$S \times \frac{0{\cdot}1635}{D \times P}$$

in which

$$\frac{0{\cdot}1635}{D \times P}$$

is a factor, a function of D, by which we multiply the degree of the saccharometer, S, to obtain the percentage of pure sugar in the dry substance in solution.

It is usual to represent the percentage of sugar by whole numbers instead of fractions: 25 per cent. by 25 instead of 0·25; 48 per cent. by 48 instead of 0·48, etc. For this reason we multiply the formula given by 100, and it becomes

$$S \times \frac{16{\cdot}35}{D \times P}$$

If now we find for every degree of Balling the number $\frac{16{\cdot}35}{D \times P}$ corresponding to it, we may form a table in which this number may be written opposite to every degree D. When we come to test a solution we find, in the first place, the indication of the areometer, and, opposite to the degree we find, in the table, the corresponding factor. In the next place we test the solution in the saccharometer, and we multiply the indication of the saccharometer by the factor corresponding to the degree of the areometer. The product is the quantity of pure sugar in the dry substance.

I have appended a table marked Duboscq, in which may be found all the factors for the degress of the areometer from 5° to 15°, divided into tenths. I have also appended another table, marked Ventzke, in which may be found the factors corresponding to the same areometer, to be used with the Ventzke instrument. This table was calculated by the formula

$$S \times \frac{26{\cdot}048}{D \times P}$$

I have adopted the areometer marked in tenths of a degree from 5° to 15°, because it suits my purpose best. Persons desirous of using any other densities may calculate tables for themselves by means of the formulæ already given. They will find that solutions much thicker than 15° are more difficult to decolorize, which will more than compensate for the advantage of using a smaller factor. If solutions are easily decolorized, it is advantageous to use them thicker, as it may be seen in these tables, that the thinner the solution, the greater is the corresponding factor. As the error of observation of the saccharometer is to be multiplied by this factor, we ought, when possible, to avoid using solutions that are too thin.*

Correction for Temperature.—In the preceding explanations there has been no notice taken of the temperature of the solutions. The indications of the areometer are true for the temperature of $17\frac{1}{2}°$ C., and if the temperature is either higher or lower, we must convert the indication of the areometer to what it would be at $17\frac{3}{8}°$. The coefficients of expansion of sugar solutions differ with their densities. The following† table gives the coefficient of *apparent* expansion for solutions when the density is taken with a glass areometer. The *apparent* expansion is the difference between the expansion of the solution and that of glass. In this table are

* In Ventzke's process, all solutions having specific gravity 1·1 are often too dark for the saccharometer. The difficulty is overcome by using tubes 10 or 5 centimetres long instead of 20. The result obtained has to be multiplied by 2 or by 4, which is as objectionable as using a thin solution, and being obliged in consequence to use a large factor.

† From Mandelbluh, *op. cit.*, p. 29.

the coefficients for every degree from 5° to 15° Balling. The coefficient, representing the expansion for a difference of 1° C., is to be multiplied by the difference between the temperature observed and 17½° C. If the temperature is above 17½° C., the product is to be added to the degree Balling observed; if the temperature is below 17½ C., the product must be subtracted, to obtain the true indication of the areometer.

Table for Correction of Temperature.

Degree of Balling.	Coefficient.
5°	0·017
6	0·018
7	0·018
8	0·018
9	0·019
10	0·020
11	0·020
12	0·021
13	0·022
14	0·023
15	0·025

Practical Directions.—Two cases may present themselves when we have a sugar solution to test; either the solution is light colored enough to be placed in the saccharometer, or it is dark and needs to be decolorized.

Suppose we have a solution which, diluted so that its density falls between 5° and 15° Balling, is light colored enough to go in the saccharometer. We place the areometer in it and will suppose that it indicates 14·3°, we next place in the solution a thermometer which will indicate say 27½° C., and we note that the excess of 27½° C. over 17½° C. is 10°. We now turn to the *Table for Correction of Temperature* and find that to 14°, which comes nearest to 14°·3, corresponds a coefficient 0·023, which we multiply by 10, the excess of the temperature observed over 17½°. The product is 0·23, which we add to 14·3, as 27½ > 17½. The result is 14·53. This comes nearest to 14·5 of our tables. Opposite to 14°·5 in the table marked Duboscq, we find the factor 1·064, and in the table marked Ventzke, 1·695.

Suppose we have a Ventzke instrument, and that the solution placed in it indicates 43 per cent., we multiply 43 by 1·695, and the product 72·885 is the quantity of pure sugar in the dry substance of the solution.

If the solution is too dark to be used in the saccharometer, it must be decolorized, which is best done by the use of subacetate of lead, to which I am in the habit of adding about one-half of sulphate of soda. In a paper written two years ago, *On the Purification of Sugar Solutions*, I advised the addition of alkaline sulphates and chlorides to sugar solutions to render them more susceptible of being decolorized by subacetate of lead. As there is no subject more important in connection with saccharimetric analysis than the decoloration of sugar solution, I will now repeat some of the conclusions reached in the above paper :—

That bone-black is not suitable for decolorizing solutions of sugar whose strength has been already determined, was, I believe, first announced by Drs. C. Scheibler and Stammer. I have given my motives for dissenting from their opinion that bone-black absorbs sugar from its solutions, and have endeavoured to show that the apparent diminution of the quantity of sugar is due to its dilution by the water contained in the bone-black, and that, when the bone-black used is perfectly dry, there is no diminution of the sugar contained in the solution.

Acetate of lead gives very irregular results. When there are salts in the sugar solution, which form insoluble compounds with lead, the results are good. With purer solutions, though they be dark, such as those of refinery products, the results are bad, both because the decoloration is imperfect, and imperfect because the precipitate obtained is so glutinous as to make filtration very slow This last is a serious evil, because solutions that have been treated with subacetate of lead become turbid when exposed to the air for a short time, so that when a solution has filtered very slowly it becomes turbid before it can be used, and requires to be filtered a second time.

The addition of sulphate of soda, which I have now used for over two years, gives a voluminous precipitate, very easy to filter and

of great decolorizing power. I have lately found that when the solution of sulphate of soda has been made alkaline by the addition of about 5 per cent. of a saturated solution of carbonate of soda, its decolorizing power is increased in a marked manner. I have also found that the addition of sulphate of soda has the property of preventing the solution from becoming turbid by exposure to the air, if enough sulphate is added. This is due to the lead being almost entirely thrown down as sulphate. In this case the coloring matter is taken up by the sulphate of lead at the moment of its formation. I have given the preference to sulphate of soda over chloride of sodium, because it precipitates the coloring matter more thoroughly. Dr. Scheibler gives the preference to precipitated hydrate of alumina for taking up the coloring matter of dark solutions, which answers very well in many cases. The decolorizing power of precipitated hydrate of almunia is, however, much less than that of sulphate of lead in the nascent state, as any one may ascertain by experiment. A very dark solution, which will have a brownish tint after being treated with hydrate of alumina, will show a bright yellow colour after being treated with sulphate of soda and subacetate of lead.

A very convenient manner of improving the color of a sugar solution having a brownish or reddish tinge, but otherwise light enough for the saccharometer, is to add a single drop of hydrochloric acid, holding in solution a small quantity of protochloride of tin. The result is to change the color into a pure yellow which gives very good results in the saccharometer.

To return to our previous subject: If we have a solution which is too dark for the saccharometer, we must at first, proceed as in the case of a light solution; test it by the arcometer and thermometer and obtain the rectified degree Balling corresponding to 17½° C. Opposite to this degree Balling we find in the table the corresponding factor, which we write down for future use. We now clarify the solution by adding to it sulphate of soda, and immediately after subacetate of lead, the volume of sulphate being about one-half as much as that of the subacetate. The total addition is usually 10 per cent. of the volume of sugar solution. If the solution is light, 5 per cent. will do.

(*To be continued.*)

Stocks of Sugar in the Chief Markets in the World on the 1st December, for Three Years, in thousands of tons, to the nearest thousand.

	1873.	1872.	1871.
Great Britain	178	169	129
France	153	76	55
Holland	33	29	28
Germany (Zollverein)	32	15	16
Six other *entrepôts*	8	7	6
Total in Europe	404	296	234

Consumption of Sugar in Europe for Three Years on the 1st December, in thousands of tons.

	1873.	1872.	1871.
Great Britain	793	704	679
France	265	237	290
Germany (Zollverein)	262	215	228
Holland	34	29	25
Six other *entrepôts*	100	86	118
Total in Europe	1,354	1,271	1,340

Estimated Crop of Beet Root Sugar on the Continent of Europe, for the ensuing Season, compared with that of the three previous Seasons.

(From Licht's Monthly Circular.)

	1873-74.	1872-73.	1871-72.	1870-71.
	Tons.	Tons.	Tons.	Tons.
France	390,000	259,000	189,000	263,000
Germany (Zollverein)	285,000	409,000	335,000	289,000
Austro-Hungary	175,000	214,000	162,000	182,000
Russia and Poland	150,000	150,000	90,000	135,000
Belgium	68,000	76,000	72,000	56,000
Holland and other Countries	37,000	35,000	25,000	17,000
Total	1,105,000	1,143,000	873,000	942,000

SUGAR STATISTICS—GREAT BRITAIN.

To JANUARY 17TH, 1874 AND 1873. IN THOUSANDS OF TONS, TO THE NEAREST THOUSAND.

	STOCKS.						IMPORTS.						DELIVERIES.					
	London.	Liverpool	Bristol.	Clyde.	Total, 1874.	Total, 1873.	London.	Liverpool	Bristol.	Clyde.	Total, 1874.	Total, 1873.	London.	Liverpool	Bristol.	Clyde.	Total, 1874.	Total, 1873.
British West India	16	1	..	22	39	36	2	1	..	1	4	5	5	..	..	1	6	8
Cuba	2	4	1	13	20	14	..	..	..	2	2	1	..	..	2	5	7	3
Porto Rico, &c. ..	..	7	..	3	10	5	..	1	..	..	1	1	1	..	..	..	1	1
Brazil	3	24	..	5	32	22	..	3	..	..	3	4	..	1	..	..	1	2
Mauritius	3	..	..	..	3	8	..	..	..	1	1	4	1	..	..	..	1	3
British East India	15	4	..	..	19	16	2	..	..	..	2	5	1	..	..	..	1	1
Manilla & Java ..	31	14	1	3	49	29	1	1	1	2	5	2	..	1	2	..	3	3
Beetroot, &c.	9	3	1	7	20	23	7	2	1	4	14	14	4	2	1	4	11	13
Total, 1874 ..	79	57	3	53	192	153	12	8	2	10	32	36	12	4	5	10	31	34
Total, 1873 ..	71	33	6	43	39 increase		15	8	26	57	4 decrease		11	5	5	13	3 decrease	

STATE AND PROSPECTS OF THE SUGAR MARKET.

The market for Raw sugar opened after the Christmas holidays with a quiet but firm tone. The buying was cautious, and evidently chiefly for immediate requirements; but on the other hand sales were not pressed, and the show of useful refining kinds by no means large; low sugar, however, was rather easier. As the month progressed the market continued dull, with few transactions, though for finer qualities with little quotable alteration in price. The course of Jaggery and unclayed Manilla, however, tended steadily downwards, the former reaching the comparatively low price of 16s., duty paid.

The political events of the last week have, of course, had an important bearing upon the sugar market; the anticipation which is prevalent that the duty will shortly be removed has already further depressed the markets, both raw and refined—the latter especially appears to be unfavourably influenced.

The latest quotations for standard qualities of Raw are as under: No. 12 Havana, afloat, 25s. 6d. to 26s.; fair to good refining Cuba Muscovadoes, 21s. 6d. to 22s. 6d; middling, to good Brown Bahia, 17s. 6d. to 18s. 6d.—prices which show, upon the whole, a decline of about sixpence for the month, and a decline of from 2s. to 2s. 6d. compared with the rates current at this time last year.

The stock of Raw sugar in the United Kingdom has been very steady during the month, and remains at present at a point little different from that which closed last year, the amount being almost unprecedently high. The rate of consumption continues to be satisfactory, and is decidedly the most hopeful feature in the statistical position. The circumstance that the consumption of Foreign refined has increased in a far greater ratio than that of British production is, however, a feature in this part of the question to which thoughtful minds will attach its due significance, remembering that if Foreign refiners are to continue to be protected as they are at present, their monopoly of the British market is simply a question of time.

THE

SUGAR CANE.

No. 56. MARCH 2, 1874. Vol. VI.

☞ The writers alone are responsible for their statements.

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THE DUTY ON SUGAR.

(From the "Journal des Fabricants," of February 5th, 1874.

The English Government has morally bound itself to remove the duty on sugar, and if a new House of Commons does not withdraw the majority from Mr. Gladstone, we may be certain that this radical measure will be carried in the next budget. It is not that the real duty is very heavy, since notwithstanding that its total is three times that of ours, the English only pay to the Treasury 1s. 2d. per annum, whilst our contribution for the same purpose is more than 3s. 10d. But other considerations are added to those of the greater advantage given to the English consumer, and that which aims at relieving from all shackles the important commerce in this commodity, is certainly not the least in the eyes of a people who know how to appreciate commercial and industrial liberty.

England is thus about to become the unrivalled metropolis of the sugar trade, and is about, by the same movement, to free itself from the bonds of a troublesome National Convention, that of 1864, which it is about to sever in the style of Alexander, being unable to solve it otherwise. British refining will undoubtedly continue to be interested in the movements of the sugar diplomacy of the continent, and of that of France especially; but it would be to misunderstand this policy of free trade, to which we allude, to

acknowledge for a moment that the British Government would not sacrifice, if necessary, its refiners, and that it would make the smallest effort to prevent our continuing to offer to the consumer of the United Kingdom our sugar made good with premiums on exportation, as it is, if such is our folly and our good pleasure.

There is, then, in the supposition of the suppression of sugar duties in England, one first point well established—the neutrality of the Government of this country in the matter of tariffs or of export, and its withdrawal from the Convention of 1864. As to the effect even of the absence of all duty on sugar, from a certain point of view, it will be considerable. Who does not see, for example, that the difference of standards or of shades will be of no interest for English trade, which will purchase its sugar for its real value, and which is about to give, in succession, the preference to crystallised and white powders ? The considerable supplies of these sugars existing at this moment in our stores or general warehouses might then very soon find a very advantageous outlet and market.

As to the future of these sugars in the English market it appears more than ever secured, and it will be still more so the day the refiners of English loaf no longer suffer, on the part of similar French products, an artificial competition which weighs on the whole market of sugars suitable for direct consumption. But that is a question to which we must return, and which cannot delay to present itself. Thus it is always that England rejoices in the particular position that it is about to have in the matter of sugar, and that it is not sparing in its criticism of the nations that do not inspire principles that it applies with so much success, which consist in the removal of all obstruction between producer and consumer. Let us mention, *apropos* of this, an article in the *Pall Mall Gazette*, which maintains that the Prussian Government wished to abandon the system of uniform duty practised by its mode of levying duty on beetroot in order to adopt that of qualities based on the produce by analysis. The same news reaches us directly from Germany, and, if confirmed, we can only regard it favourably, since the new system will be of such a nature as to put a stop to the excess of production reached by the manufacturers of this country.

The discussion on the laws of duty commenced last week, at the National Assembly, by a discourse by M. Magne, Minister of Finances, who has not spared our merchants and manufacturers, whom he represents—wrongly we think—as inimical to all the arrangements for equalising the budget, and little disposed to bear their share of the heavy duties which ought to weigh upon all. It would be for that above all that he would have chosen the duty less hurriedly, only rendering account of all the new duties, that is the least equitable and that which takes us furthest from the proportionality sought to be reached. This duty would be fatal to many of our workshops, particularly of those that are far from mines and competing markets; and it would be most inconvenient for our commerce, of transit and of export.

M. Magne, on the contrary, does not agree with the advice of the Commission as regards the new duty on alcohol; and he has remarked, most logically, that a matter which has caused a deficit of 22 millions, such as that of which we speak, should have grace, and that we could not really ask more from it. We shall be very happy if this declaration of M. Magne may have been able to convince the Commission, but on condition that they do not return from it to the project of again pressing on the sugar. We know that this project has been drawn up by the Commission of the Budget, and M. Germain, its author, has come to bring it to the Tribune of the Assembly, in the midst of the exclamations of the Northern Deputies, who have reasonably demanded if the destruction of the sugar manufacturer was intended.

The sugar trade really undergoes, at this moment, a serious crisis for want of expedients. The interior consumption, led away by exaggeration of the duties, makes no progress, whilst the exportation of native raw has diminished in disturbing proportions, and presents in 1873 over the year 1872, a diminution of 28 million kilos. Our stores overflow with unsold sugar, and there are manufacturers who, not wishing to hurry to ruinous prices, have even yet all their production in the country. The moment, we must acknowledge, would be strangely chosen to raise anew the

sugar impost; no more is needed to complete the ruin of this trade, and, in consequence, that of the agriculture of the whole North, to which its interests are firmly bound.

In truth, the theories entertained about sugar are deplorable, and our economists in the Chamber have great need to go to the school of Lowe and Gladstone to learn true principles on this subject. It is thus that M. Germain, notwithstanding all his talent, has come to maintain that there can be no hesitation between salt and sugar, the former of these two products may be considered as the consumption of ease, the other of poverty. So the sugar, which forms an integral part of chocolate, which is the indispensable condiment for coffee, which enters so largely into fruit conserves and into a crowd of aliments which form the foundation of the food of women and children, *sugar* is a luxurious food consumed by reason of the ease of the consumers! Such a mighty error surpasses us, and we cannot understand how in the Assembly there was not found an authoritative voice to protest against such economic sophistries, as has been done rightly, from another point of view, against the socialist declamations of M. Lockroy.

We maintain, for our part, that sugar is not a luxurious food, and that only the enormous duty with which it is oppressed can cause it to merit this false qualification. This product, of which the Anglo-Saxons make little, and which they propose to give to their animals to eat, is so little an article of luxury that an aggravation of the old duty, already very high, by more than 50c., cannot stop the consumption. Notwithstanding the imposition of 70f. for 100 kilos. which beats upon it, we consume as much of it as in 1869, and we ask to what figure this consumption would rise if the duty was more moderate. No, this is not the food only of the rich, it is also that of the poor. That is what your rigid political financier is enabled to allow, without doubt, but which you will perhaps understand when you will have dried up the source of this marvellous industry on which you strike with redoubled blows, so much have you found it compliant and productive.

Moved by a patriotic feeling and by the necessities of our budget, we have bowed before the first aggravations of tax that sugar has sustained; but we find to-day the point has been passed which cannot be passed without danger. Last year 33 new manufactories has been established, and the cultivation of beetroot had taken a noble development. This year there only exists, to our knowledge, a very small number of new projected works, and manufacturers must have great caution in dealing with the cultivators. It is because the production is struck at its source, and it is necessary to examine it before entering into a trade of which the interior market is narrowed in place of extended, and which no longer exports with the same activity: a position full of dangers, before which our legislators should take the trouble to stop.

There are limits that the duty, however greedy it may be, cannot pass, and that of sugars has reached a point that prudence forbids us crossing. It is neither wise, prudent, nor politic to weight a product with 125 per cent. of its value, when in neighbouring countries this product with many others is about to be freed. Who does not see, on the other hand, the serious annoyance of that excessive fiscal interference, which is such a strong enticement to the legal fraud to which, as we know, the sugar system gives rise. The more the duty will be raised, the more will really be raised the premiums enjoyed by the refiners on exportation by the difference of produce, the greater also will be the credit of the State, which by means of four months' obligations acts as banker for these manufacturers, of whom the flourishing condition contrasts sadly with the precarious one of a great number of manufacturers. It is not enough we see to declare to the tribune that sugar can bear ten, twenty, or twenty-five per cent. more; we must weigh the varied consequences of this senseless oppression, which will be to discourage and finish by destroying one of the most beautiful and useful industries of the country.

THE DUTY ON SUGAR.

From the "*Journal des Fabricants*" of Feb. 12th.

The debate upon the duties still continues to engage the National Assembly, and in last Saturday's sitting, M. Léon Say delivered an excellent speech against the new surtax, which the Commission propose to put upon alcohol. Although it may be true, that alcohol is, to use the current phrase, an article eminently taxable, there are yet limits to the amount of duty which it ought to bear, and the late Minister of Finance scarcely required to prove that these limits have been attained, if not surpassed. In England, the rate of 10s. per gallon of 57° to 61°, which is equal to about 400 frs. per hectolitre of pure alcohol, is doubtless very much higher than the duty proposed by the Commission; but, in England, where they have neither vines nor beetroots, there are only large distilleries easy to supervise, and fraud is consequently more difficult to practise. M. Léon Say instanced as well from the history of the United States and of England, as from that of our own country, numerous and striking examples of fraud, which prove that it is always dangerous to exceed the natural limit of duty, and showed indisputably that the projected addition to the duty upon alcohol would be both immoral and unfinancial, in that it would only serve to encourage fraud and drunkenness without even benefiting the Treasury. M. Léon Say might have added from another point of view, and we have before had occasion to remark this, that, whether or not, the raising of the alcohol duty in England be justifiable in itself, this measure loses much of its oppressive effect, in a country where the taxes upon the consumer are so light and tend constantly to be lowered, if not suppressed. The English consumer who pays scarcely anything upon his tea, his coffee, and his sugar, is able without inconvenience to bear a heavy tax upon spirits, whilst, in France, everything is taxed with a heavy duty, a state of things to which, alas, we cannot see any end. In spite of the eloquence of M. Léon Say, the new duty upon alcohol has been agreed to, the additional amount being

estimated at 24 millions of francs. Let us hope that sugar may escape such a fate, against which the beetroot industry, which has experienced during the last few years such severe trials financially and industrially, cannot protest too soon or too energetically.

We have already published the projects of the Gladstone Ministry relative to the sugar duties in England, which were generally considered to be on the eve of abolition. The defeat of the Liberal party in the elections and the probable event of a new ministry with Mr. Disraeli at its head will most likely postpone this measure, which does not enter into the plans of the Conservative leader. Mr. Disraeli has, in fact, formally declared, under various circumstances, that he was not prepared to abolish any source of revenue; and although the financial position of England does certainly admit of the realization of those schemes for reduction announced by Mr. Gladstone, yet it is to be doubted, for reasons of general policy into which it is not our place to enter, whether his successor will be disposed to adopt them. It is very desirable that the course to be followed upon this matter shall be promptly declared, for it is well known, that during the last few weeks, the sugar trade believing the abolition of the duty to be impending has been inactive, and this to the great detriment of our own market, which already was in such a state as to want nothing more to become completely paralyzed. There is also another point of view from which it will be scarcely less interesting to learn the intentions of the new minister, for to him will doubtless fall the task of calling together the four Powers in view of the revision or dissolution of the Convention of 1864. Here is a question which might appear to be independent of that of the sugar duty, but which in reality is closely connected with it, inasmuch as the total abolition now practicable would be the proper solution of those otherwise insurmountable difficulties which the question of a new Convention presents. Assuredly, if our own finances were in the same prosperous condition as those of England, and exhibited regularly a surplus of four or five millions each year, few French Ministers could resist the temptation of solving the sugar question in the same manner as Mr. Gladstone

proposed to do, and the new *projet de loi*, which has been the subject of so much discussion, would be withdrawn before the second reading.

The position of the sugar market, to which we have alluded above, is unfortunate, and we should have to go far back in order to instance a time of dullness so complete and lasting. Everything points, however, to the conclusion that we have reached the culminating point of this crisis, and that an improvement of which the causes are becoming visible will not be long in manufacturing itself. Under such conditions statistical statements possess a great interest, and we therefore call attention to the figures for 1873 compared with those for 1872, which appeared in our last issue. It results from these figures that the importation of colonial sugars has been 86,953 tons against 87,466 tons, that of foreign sugars 97,614 tons against 102,405 tons. The production of French beetroot has been 415,548 tons against 375,590 tons in 1872, making a total supply for 1873 of 600,115 tons against 565,461 tons last year, an excess of 34,654 tons. This excess is relatively small, and would not have had a depressing effect upon the market unless accompanied by a considerable falling off in the exportation of indigenous raw sugar, which has this year been only 62,029 tons against 99,191 in 1872, being a deficiency of 37,162 tons.

With regard to deliveries for consumption, they have reached in all 436,924 tons, against 364,413 tons, whence we must deduct the exportation of refined sugar, which, expressed in terms of raw, is 184,033 tons, against 171,267 tons in 1872. The extra exportation of refined, therefore, has only been 12,756 tons, which is far from compensating the deficit on the exportation of raw. We may remark, however, that of the 153,185 tons of refined exported in 1873 against 141,185 tons in 1872, eleven out of the twelve thousand tons excess are for England. It is plain that this excess only communicates with the *fabricants* by the channel of the French refinery; and it is well known what sort of a price is there exacted for such services, which, however, although so highly sounded, our *fabricants* might readily dispense with by exporting their own pro-

duce to the English market, were that only possible. Regarding the quality of the indigenous raw sugar exported to England or elsewhere, we find—

	1872.	1873.
Under 13 D.S.	56,407	24,473
From Nos. 13 to 20	17,040	15,325
White crushed	23,235	28,475

which last is small considering the large quantity of this sugar produced this season. As for the consumption for 1873 it is estimated at 252,901 tons. We will say nothing of the revenue from sugar, which reached in 1873 the Budget estimates, yielding 170,705,032fr. (£6,828,000). But we know that this figure is not the result of a rigorous calculation, and that it only represents the sugar upon which duty has been paid, that is to say, a quantity too small by the amount of the bonus yield which there is no question that our refiners enjoy. The most that can be said is that this bonus, recognised by the Minister of Finance, has not exceeded his previsions.

The fact must not be disguised that the low price of sugar—so low as to prevent the consumer feeling the increased duty—has created alarm in quarters where we wish to carry reassurance. We find in an excellent statistical treatise by Messieurs Rueb and Ledeboer, of Amsterdam, the foundations for this feeling of confidence which a study of the position of the beetroot industry is, after all, calculated to inspire. We gather from the table before us, which comprehends the sugar production of the world for 20 years, the following condensed information :—

Sugar Productions from 1853 to 1873.

	1853.	1863.	1873.
	Tons.	Tons.	Tons.
Java and Madeira ...	100,000	125,287	207,842
Cuba	322,025	506,860	711,795
Inrinam	16,520	13,683	12,291
Manilla	40,000	83,151	91,701
Porto Rico	111,975	63,000	89,559
Brazil	138,000	238,280	157,809

	1853. Tons.	1863. Tons.	1873. Tons.
Mauritius	80,811	158,209	124,806
English Antilles ...	61,000	13,894	21,279
Natal	...	1,317	8,872
Jamaica	21,361	28,444	*26,269
Barbadoes	25,556	29,573	*37,762
Trinidad	24,010	37,421	*60,032
English Guinea ...	38,096	53,974	*13,556
Australia	2,485	2,988	*4,920
Louisiana	224,662	...	69,800
Martinique	20,700	30,459	39,699
Guadeloupe ...	14,800	30,266	31,786
Réunion	33,100	68,616	30,450
Cayenne	300	420	*324
Egypt	1,303	341	20,359
Europe (Beetroot) ...	200,000	452,129	1,142,896

We see by this table that the production of the countries above specified was 1,476,714 tons in 1863, 1,938,322 tons in 1863, and in 1873, 2,954,722 tons. It has therefore doubled in a period of 20 years, and this has been accompanied by a very considerable increase in the consumption. It is remarkable that the production of exotic sugar has in 20 years only increased from 1,276,714 tons to 1,811,826 tons, and also that this increase is confined to a few countries. The chief of those in which progress has been made are Java, Cuba, Manilla, the French Antilles, Jamaica, English Guinea, and Egypt. Everywhere else the production of cane-sugar has extended but little, and in several cases it is notoriously on the decline. The great colony of Cuba itself only shows slight progress, and the considerable variations in its production appear now to be due to the abundance or deficiency of the crop. It is, therefore, upon the beetroot that appears to devolve the task of feeding the growing consumption of European nations and those who are supplied by their exportation, and to this

* 1871.

end it is that amongst those nations who cultivate the beet the keenest and most determined competition will arise.

From this special point of view the old convention of 1864, which contemplated only the exportation of refined sugar, and which regards only the interests of the refiners of the four nations, rests, we must confess, upon a basis which is very narrow, and henceforth inadequate. The interests of the beetroot industry have become extended and magnified, and they should now have free access to the vast field for exportation, not only under the form of refined, but also under that of raw. We are led to the conclusion that it is very desirable and contormable to the future interests of the beetroot cultivation: that a uniform system of European sugar legislation should be adopted, and that meanwhile such arrangements should be made as will permit of perfect reciprocity and a fair competition amongst the various producing countries.

B. Dureau.

ANIMAL CHARCOAL IN SUGAR MANUFACTURE.—I.

Charcoal acts visibly on the foreign organic substances in sugar syrups. In the first place, the colour is removed from the juice. We are apt ordinarily to regard this decolorisation of the juice as the measure of the action of charcoal, but this is wrong; though the decolorisation may be the effect most easily remarked, there is nothing that permits us to assume that the action of charcoal would be uniform on substances coloured or not coloured.

Thus, for example, bone charcoal having undergone a ferment with molasses, and then a burning without previous washing—in other words still retaining potash—possesses an enormous decolorising power; but if employed for the filtering of juice in that state it produces a bad and viscid "strike."

If decolorisation were the sole end of this process, we could arrive at it better by the use of blood-charcoal, which decolorises ten to twenty times as much as bone charcoal.

It is evident that the nature of the substances eliminated from

sugar syrup by charcoal is different from that of the substance extracted by defecation. Filtration without that property would be superfluous, and could be replaced by defecation.

These are more especially combinations of alkalis with certain organic substances, belonging probably to the *rôle* of acids, since the same alkalis and alkaline salts, though incapable of being extracted by lime, are in part absorbed by charcoal.

It seems certain that one portion of these substances, above all the salts having an organic base and acids having an organic origin, most effectively hinder the crystallisation of sugar, and that they are the unmistakeable "molasses-formers."

We know, for example, that neither citric acid nor oxalic acid can be entirely precipitated by lime in an alkaline sugar solution, though we do find at times large quantities of citrate of lime in the filters.

A mixture of salts and organic substances will act more against the crystallisation of sugar than the salts alone.

Certain salts (such as chlorides and saltpetre) are not absorbed by charcoal, but are crystallised with the sugar.

The physical and chemical properties of charcoal have a marked influence on the effect produced; that is to say, that according to these properties the same quantity of charcoal will purify a larger or smaller quantity of juice to the same degree, or the same quantity of juice to a lower or higher degree.

We distinguish the most active charcoal by a very marked blackness without sparkle, but of a certain velvety appearance. It should be sufficiently dense, but still very porous, adhering to the tongue, or in other words, absorbing moisture with avidity.

Greyish charcoal more or less sparkling, absorbing moisture slowly, together with charcoal light, spongy, and of a sparkling character, although black, have a much inferior effect.

The bones which form the raw material for the preparation of animal charcoal are composed of mineral substances and organic tissue or cartilage. During the burning, the first remain intact, the second is carbonised, and the product remains as an intimate association of "bone cinders" and "animal carbon."

The porosity of the charcoal is the consequence of the anatomical structure of bone, and of the infusibility of its mineral components. The greater portion of the organic matter consists of a spongy tissue, in which is found intermingled inorganic substance. Calcined bones, in consequence, are formed, so to speak, of extremely small cells, of which the sides are covered or clothed with the carbon of the cartilaginous tissue, which is of extreme tenacity and delicacy.

Opinions differ as to the explanation of this action of charcoal on solutions with which it comes in contact. It is generally received to be the effect of surface.

All solid bodies possess the power of condensing, so to speak, on their superficies, solid matter dissolved in liquids, and this faculty becomes much more decided when the surface is very extensive. Animal charcoal, with its microscopic cells, possesses an enormous surface, and thus can exercise the action in question to a very high degree. However, surface alone does not determine the purifying action. Substances other than animal charcoal, with a surface correspondingly great, produce a far less effect; so thus the nature of the filtering medium has a very great deal to do with the results obtained. Thus, for example, if we bring charcoal to the red heat in contact with the atmosphere, the carbon contained is destroyed, and the mineral portion only remains in a state of division, forming "bone cinders;" but the action of this cinder is infinitely less than that of animal charcoal before incineration. Thus we see that the absorbing action of animal charcoal is not the result of the property due to surfaces in general, but a special effect peculiar to porous carbon, such as results from the calcining of the cellular tissue of bone.

In general, the colour of bone charcoal furnishes an indication of the quantity of pure carbon it contains; the more the colour inclines to a grey, the less carbon it contains. That explains the feeble action of grey charcoal. We must, however, remark, that to enable you to judge by the colour, the charcoal must be taken in a perfectly dry state, dampness having the effect of deepening the colour.

The proportion between the mineral and organic constituents of bone is not the same in all kinds of bones; it varies with the parts of the same body, and also with the age of the animal. Hard and compact bones contain less cartilage than spongy and softer bones—even in the same piece of bone the proportion varies in the outside from the inside. From this it would appear that the most cartilaginous bones would give the best producer; but it is not so. Too great a proportion of organic tissue clogs, to a great extent, the free action of the porosity of the charcoal. Where the tissue exists in a fair proportion, the phosphates retard the fusion of the cartilage during burning, and the cellular tissue is preserved; if there is too much cartilage, it melts away during carbonisation, and gives place to a dense and shining charcoal, which obstructs the pores of the charcoal produced. It is only hard and compact bones which furnish charcoal of the best quality for sugar-making, while spongy and cartilaginous bone gives a shining product of poor qualities. In accordance with the results of the foregoing remarks, we recommend for the use of the sugar factory the freshest and most compact bones. The more slender bones, or spongy ones from the heads, the interior of the horns, or even those that have remained any length of time exposed to the air or in the earth, make but bad charcoal.

To sum up: Take bones containing neither too much nor too little organic matter, nor those of a light and cellular formation, as from these is only obtained a charcoal of poor strength and durability. The grease contained in the bones is removed before calcination by means of hot water or steam. The grease is reserved and used for lubricating purposes, or for soap-making, and in some parts the water is used as manure. During the manufacture of phosphoric manures the bones are treated with steam at a high temperature; but this course would be faulty when the bones are required for burning, since a great quantity of the cellular tissue would be destroyed.

Still, however, when the bones are to be broken before calcination, to enable a choice to be made of the best samples for the purpose, the bones have previously to be dried, which sometimes is

done by the waste heat of the furnaces, or by direct steam; this process, however, is not allowed for any length of time, and the pressure is low, the contrary never failing to hurt the quality of the charcoal.

The dry bones, after being broken, are in the condition of large pieces, and are generally burnt in furnaces of a very simple construction. It should be understood that we are now speaking of the process employed on sugar factories in the beet districts of the Continent. Generally speaking, however, the factories there, as well as the refineries in Great Britain, purchase their charcoal ready made from firms who make its preparation their business. But some few factories make their own charcoal, for reasons not requisite for us to state in this article.

The furnaces for making animal charcoal are cylindrical pots of cast iron, which are filled with bones, and piled one on the other, so that each pot may be closed by the upper one, and the highest is closed by means of a cover.

Very recently these cast-iron pots have been replaced by those of fire-clay, of the same form and prepared in the same manner as gas retorts. These pots appear to present some advantages; the return of charcoal from them is greater, and they seem to be the only pots that do not lose their shape in the fire; keeping themselves better closed, and thus avoiding more perfectly the combustion of the animal charcoal. Then, again, it is sometimes found advantageous to place the pots in a single horizontal row in the furnace; everything else is the same, save the height of the furnace. The furnaces are of the reverberatory type, with external firing places, the flames enveloping the columns of pots on all sides. When the furnace is full, and the openings that may still present themselves in the pots are carefully luted, the temperature is then raised to the red heat and maintained at that heat during six or eight hours, with a small quantity of combustible, for the carbonisation of the bone is attained in part by the aid of the flame produced by the combustion of the gases escaping from the pots. They then proceed to draw the furnace as soon as it has sufficiently cooled.

Regularity in heating is an essential condition of this manufacture, thus avoiding either excess of heat or the contrary, both of which faults have a bad effect on the product.

If the bones be incompletely carbonised, they retain organic matter and crude products occasioned by the heat, which are partially soluble. Bones in this state are poor decolorisers, and deteriorate the juice. Charcoal too much calcined has the same fault, for by the elevated temperature the phosphate of lime has undergone a very observable contraction, which renders it less pervious and diminishes the surface of the charcoal accessible to the liquid. The bones are allowed to cool, and are then withdrawn from the pots and reduced to grains of various sizes suitable for filtration. As very fine charcoal cannot well be revived, and as it does not possess the same value as charcoal in grains, one should avoid as much as possible the production of powder or meal. To obtain the charcoal in grain, fluted rollers are used, formed of toothed discs of about $9\frac{3}{4}$ inches and $11\frac{3}{4}$ inches diameter alternately. These cylinders are arranged in such a way that the discs of the smaller diameter on the one correspond with those of the larger on the other. By the rotation of these cylinders the bones are broken, not crushed or ground, and are passed through a series of these mills, which are arranged one above the other, the cylinders of which are placed more and more closely together as they descend. The charcoal thus crushed is passed through a bolter or cylindrical sieve to separate the flour and to obtain charcoal in grains of various sizes.

The furnace we have just described has the disadvantage of interrupted action, and in consequence is extravagant of the combustible used, and has a small power of production in consequence of the periodical interruptions of the calcination. Many plans of construction have been proposed and carried out to render the production continuous and the work uninterrupted. These are also used for the revivifying of the charcoal, and usually consist of vertical cylinders of cast or wrought iron, with covers on the tops, the upper part of the cylinder being used for the burning process, the lower half, separated horizontally by a fire-brick partition,

being used for the cooling process, the finished charcoal being removed at the bottom by means of sliding doors.

The proportion of charcoal obtained varies with the kind of bones employed, but may be approximated at about 60 per cent. of the weight of the bones calcined.

We have already alluded to the composition of animal charcoal in general, as being an intimate association of porous bone earth and carbon from cartilage. The proportion of carbon is about 10 per cent.; the remainder is composed of phosphate of lime, about 78 per cent.; carbonate of lime, about 8 per cent.; phosphate of magnesia; gypsum; soluble salts; sulphate of calcium; silica, &c. In the air, animal charcoal absorbs from 7 to 10 per cent. of moisture.

We may now proceed to speak of the process of revivification.

On commencing the revivification, the charcoal is placed in a heap and slightly damped; fermentation or putrefaction commences under these circumstances, which destroys the organic substances absorbed. The charcoal is then dried, and heated to a red heat, with frequently the addition of fresh bones.

This process is quite correct from this point of view, supposing that the charcoal has only absorbed organic substances; but it is usual to submit the charcoal, from time to time, to the action of diluted hydrochloric acid to dissolve out the earthy salts which had closed the pores of the charcoal. It is generally believed that the earthy parts, which are only incompletely separated during the primary evaporation, are finally deposited during filtration, consequently these impurities should be removed from time to time. It is observable that juice uniformly treated with revivified charcoal becomes less easy to work in a short time, and the quality is found to be restored by the use of new charcoal. The charcoal consequently loses its efficacy by its reiterated use, the reason of which is generally allowed to be the result of the lime absorbed during each filtration and very incompletely eliminated by the revivification. From this cause the regular employment of hydrochloric acid was only a step, and it soon was adopted in all the sugar factories. Revivification thus consists of washing, fer-

mentation, acidulation, washing and burning. At first the acid was added without any fixed rule, but now an analysis of the charcoal is made, and from 4 to 5 lbs. of hydrochloric acid, of from 21° to 22° Beaumé, is allowed to neutralise about every 2¼ lbs. of lime found in the charcoal.

Many different modes have been suggested by chemical intelligence devoted to this subject, and the above operation has been diversified in detail, but in the main remains the same. We may here remark that no part of a sugar works requires more attention on the part of a chemist or overlooker than the purification of the charcoal, that is, if they wish to avoid extra work and expense, and to arrive at a good result with the least possible risk.

If we consider the object of revivifying as a whole, it principally consists of dissolving and purifying the char from the lime absorbed, without injuring the char itself, as well as to eliminate as completely as possible the organic matter also absorbed, and that in a manner which shall obstruct the pores of char as little as possible, as we have seen that its effect so much depends on its perfect porosity; and lastly, to extract certain other matters which could have been absorbed, such as sulphate of lime, &c. To remove the lime absorbed by the char, there is no better means than hydrochloric acid, which is a safe and sure medium except it be employed in excess. It dissolves the lime without attacking the tissue of the char, as long as the quantity used be no greater than the proportion of lime present requires. The hydrochloric acid may be the usual acid of commerce, but it should only contain traces of sulphuric acid. This acid, which is almost always met with in hydrochloric acid, gives rise to the presence of sulphate of lime or gypsum in the char, which greatly reduces its activity, and gives a great deal of trouble to extract. One should determine from time to time the amount of this acid in the hydrochloric acid in use. It is rather difficult to fix a limit to the proportion which may be allowed to pass so that it will not injure the char. As a rule, choose the purest acid obtainable, even at a higher cost, and specify (for example) that the hydrochloric acid shall not contain more than 1-10th or 1-20th per cent. of sulphuric acid.

We should here remark that the use of hydro-chloric acid would not be so frequently needed in sugar factories in this colony where the usual means of defecation are in practice; its frequent use, referred to previously, is rendered necessary by the defecation by carbonic acid gas, after the exhibition of more lime than is used in the ordinary tempering in general use here. In fact, it would only be had recourse to when the char was becoming sluggish, and the washing, fermentation, and burning processes were apparently not succeeding in properly renewing it.

We will now proceed to the next stage—fermentation. This, as we mentioned previously, is a process of decomposition of the nitrogenous or organic substances absorbed. Two processes are in use—one called "water ferment" and the other "dry ferment," according as we may submit the char to decomposition while covered with water added, or exposed to the air with only the dampness retained on leaving the filters. The "water ferment" is characterised by an extremely disagreeable smell, and by the difficulty, often very troublesome, of getting properly rid of the fetid water; in addition it is necessary to use fermenting tubs either of wood or cemented masonry; but in spite of these drawbacks it is more frequent in the continental refineries and sugar factories than the "dry ferment," as it is completed in a much shorter time. The necessary period there is about seven days, but in case of need, five to six days fermentation is made to answer; while, in the case of the "dry ferment," ten days is the shortest time allowed. During this time (we are now alluding to the "dry ferment,") there is a very considerable increase of temperature in the heap of char, until it has attained a maximum, then the temperature commences to fall; this, however, does not always indicate that decomposition is completed, for an increase of temperature is again noticed some time after. In fact, the duration of the time depends upon the local temperature and the freedom from cooling currents of air, which can retard the process sadly. The principal reason for this process being less in favour is the large stock of char necessary, and, as far as can be discovered, the effect produced on the char is much the same in

both processes; and the same remark applies to the product from the two chars. For some time, however, the "dry ferment" was thought the best, but unhappily the exterior layers of the heaps ordinarily escape putrefaction in consequence of the radiation of the heat, which thus becomes insufficiently elevated. This is a considerable drawback to the process. However, the expense of providing char became a sufficient reason for deciding between two methods so very similar in their results.

It is rather a disputed question as to whether the acid treatment should or should not precede fermentation; generally, however, in practice it comes after it.

We recommend that in every case the char should be washed previous to acidulation (if used) and to fermentation.

It has been suggested to replace the fermenting process by the use of carbonate of soda, or, better still, caustic soda; but the cost of this medium and other chemical reasons have tended to prevent it being generally adopted.

After this treatment the char is washed in several waters at the boiling point, and as pure water as possible. At last the black is dried and burned in revivifying furnaces to remove the water and the small quantities of organic matter which escape decomposition during fermentation. After burning, the char is renewed and ready for work.

In spite of all the care used in the carrying out of the details of these diverse operations, the effect of the char suffers a slight depreciation at each revivification. The oxidation of a small quantity of the carbon cannot be entirely avoided. The proof of this is the *grey* colour of char often revived. In addition, it is impossible to remove the last traces of the impurities; thus the pores become gradually stopped up, and in consequence the char becomes more dense and less adherent to the tongue.

After fermentation and the other details of the operation of revivifying, washing has often been alluded to. This was done at one time by hand, but in works of any great extent washing machines are in use. In hand washing, a trough longer than it is broad, and of

little depth, is filled with char, which is moved backward and forward slowly by means of shovels, while a stream of water traverses the trough in an opposite direction. The waste water is conducted to a reservoir, where it deposits the particles of char removed by it.

They blame hand washing for pulverising the char too much, so occasioning a very marked loss. This disadvantage is less than another, which is, that the washing is never done carefully without a constant and particular overlooking, and unless this overlooking has been provided you are never sure of good results; and as badly-washed char deteriorates much quicker than is generally thought, we think it is preferable to abandon this process to machines, which have a constant action.

Many washing machines have been proposed and employed. Among the most simple, but not now much used, was a trough in which worked an Archimedean screw. The trough was inclined, and received the char at the lower end of the screw, which elevated it little by little till it came out at the top. During this passage the char was showered on by a current of water in a perforated pipe running the length of the trough. This was abandoned as being wasteful of the char.

Other machines, being more complicated in their detail, cannot be described intelligibly without the aid of drawings. Whatever may be the kind of washing machine used, it is always right to pass all the discharge water through a strainer, and then through one or two reservoirs to deposit the particles of char carried over; these depôts are cleaned out from time to time, the grain is preserved for use, and the remainder is laid aside for manure.

After the washing, it is generally a practice to submit the char to a purge by steam. The effect of this is not only a certain cleansing of the char, but a preparatory drying, and in consequence an easier transport to the drying places, and a more certain result when undergoing that operation.

The furnaces for revivification are constructed after many different plans. To describe these as fully as they should be would require drawings for reference; so we can only give a general idea

of the leading points in these furnaces. They consist for the most part of circular cast iron (sometimes wrought iron) pipes set on end in a furnace, similar to those described in the formation of char from the raw bones, but in this instance the heat is a little differently applied. The lower part of the tubes are below the furnace, and are used as cooling surfaces. The lower part of the portion in the furnace is exposed to the greatest heat, and the upper to a less heat. The waste heat passes under the drying platform, and thence to the chimney. The lowest part is closed with sliding doors, and from time to time a certain portion of the char is allowed to fall out, and its place is filled by the same measure of red-hot char from above the top of the tube, being then filled up again from the material on the drying table. In some furnaces the gases escaping from the tubes are retained and brought back by means of tubes opening into the furnace fires, so economising fuel.

The graining of the char must now be alluded to. Although coming in rather late in the article, it applies as much to the first manufacture from the raw material as to the latter operation of revivifying, and on it depends a good deal the effect of the filtration. The smaller the grain the more efficacious is the char. The reason is clear; char, in spite of its porosity, acts principally in its surface, and the interior of the grain exercises only a very modified effect on the juice. It is not difficult to explain this undoubted fact. It is natural that the juice, from the commencement of its contact with the grains of char, deposits the foreign substances contained in it on the exterior surface, and the interior only receives the first of the purer juice, which later on is not easily displaced by the more impure juice. Probably, also, the deposit of foreign matter on the exterior layers tends to mechanically diminish a complete circulation, and to hinder the interior layers from exercising their action. This is certain—that char acts more powerfully the finer it is, or that it possesses more *fresh surfaces*. In practice, however, it is found difficult to use too fine grain in consequence of the difficulty with which concentrated juice percolates

through the compact layers that fine char forms in the filters; and again, the revivifying of this char is difficult and costly from the inevitable waste that takes place. A mean size of grain, say from 1-8th to 3-16ths of inch cube; but this varies with the opinions of the various sugar makers and the results they require.

EMPLOYMENT OF PHOSPHATE OF AMMONIA AND OF BARYTA IN THE PURIFICATION OF SACCHARINE LIQUORS.

By M. Lagrange.

[*Comptes Rendus, 24th November*, 1873.]

The methods of purification at present employed in sugar manufacture are almost all based upon the action of lime and the elimination of that alkali by carbonic acid. They allow a certain proportion of organic matters and mineral salts to remain in the saccharine liquors, and these substances prevent, to a certain extent, the crystallisation of the sugar. Now, it is a fact, well-known to science, that these bodies are the cause of the formation of molasses and the carrying off of sugar in these residues.

The process which I have the honour to communicate to the Academy is based upon the elimination of the organic salts of lime, of certain vegetable acids combined with potash and soda, and of alkaline sulphates, existing in saccharine liquors, by combining the action of baryta and phosphate of ammonia.

In working the syrups there is a principle which we must vigorously observe, if we do not wish to transform crystallisable sugar into glucose: it is the principle of alkalinity.

Now all syrups and sugars have been hitherto maintained in an alkaline state only by the use of lime.

That lime, introduced at the commencement of operations into the cane or beet juice, exists in these liquors in a soluble state,

and it also combines with vegetable acids to form organic salts of lime which are soluble and very stable. These salts of lime are indecomposable by carbonic acid, while the lime itself is eliminated by that gas.

These organic salts of lime, which resist the action of carbonic acid, cause great difficulty in working the sugar as well in sugar-works as in refineries. They have a very injurious effect upon the "cuites" mass, which they render heavy and sticky, giving imperfect crystallisations and long "turbinages," and, as a consequence, a bad yield. Charcoal alone, in the proportion in which it is employed, does not suffice for the absorption of these salts.

I employ with success the basic phosphate of ammonia for the decomposition of these salts of lime; in this reaction phosphate of lime is formed and ammonia is set free.

The juice and syrups, containing no lime in consequence of its elimination by the phosphate of ammonia, would, by the prompt evaporation of ammonia, quickly become neutral and then acid. At this stage I have recourse to the baryta, or the sucrate of baryta, previously obtained with the molasses or syrups, to complete the purification of the saccharine products. The baryta possesses a double action; it decomposes the alkaline sulphates (forming sulphate of baryta), also several organic salts of potash and soda, and it gives rise to insoluble compounds in an alkaline medium. Now this liberation of potash and soda not only favours the insolubility of the organic salts of baryta, but serves to keep up the alkalinity of the syrups deprived of lime, during all the subsequent processes of manufacture, until the last stage, the formation of molasses, is reached.

The industrial problem which I have solved in applying to the manufacture and refinement of sugar, the phosphate of ammonia, and the baryta is how to succeed without lime or salts of lime, the mineral salts and organic matters being eliminated in working the liquor so as to keep it in an alkaline condition, and prevent the formation of glucose at the expense of crystallisable sugar. The application of this process will be of great use, especially in the manufacture of cane sugar, in which the salts

of lime, and the great facility with which glucose is formed, occasion such serious difficulties and great losses.

In sugar manufacture it is ordinarily with syrups of 20° Baumé that the classification is effected, syrups that have generally already undergone the "calco-carbonic" treatment. The liquor being conducted into a copper with a serpentine or double bottom, the phosphate of ammonia is introduced in the proportion of the lime, of which the quantity has been ascertained by hydrotrimetric analysis, so as only to leave in the liquor a thousandth part of lime, absorbable by the charcoal; the baryta is then added in the proportion of the sulphates and organic matters, so as only to leave a hundredth part of the matters still precipitable by baryta: the mixture is brought to the boiling point, and conducted to the "Taylor" filters. The clarified liquor, on leaving these filters, is directed on to the charcoal after having left in the bags a precipitate which constitutes a valuable fertilizer.

In refining, the clarification takes place in the copper for dissolving the crude sugar. The powdered bone-black and blood, whose use occasions such serious consequences by the fermentations which they are so apt to develop, are omitted, the phosphate of ammonia, previously dissolved, being substituted for them, in the proportion of the lime, only leaving a hundredth part of that alkali which the char entirely absorbs; then the solution of baryta is added in the proportion of the alkaline sulphates and organic matters contained in the sugars, so as to leave the quantity of alkali necessary for easily keeping up an alkaline condition till the stage of molasses is reached.

In order to obtain the maximum of yield, manufacturing experiments have shown me that, for an average of sugar titrating 88 degrees, the proportion of crystallised phosphate of ammonia is 800 grammes to the 1,000 kilogrammes of sugar, and that of baryta, for the same weight of sugar, *is three kilogrammes*, employing the hydrate with 10 equivalents of water.

The mixture after solution is brought to the boiling point; at that temperature the precipitate swells, and there is effected at one and the same time a true chemical purification and a clarifica-

tion equal to that obtained by the albumen of the blood. The syrup is conducted into the Taylor filters, then to the charcoal, after which it undergoes the usual series of operations. The precipitate which remains in the bags is, after being washed, passed to the filter-presses. The cakes remaining in these presses constitute an excellent fertilizer.

The working of the "cuites," the crystallization, and the "turbinage" are accomplished with the greatest regularity and under the best conditions. The result of the employment of these two substances is shown by an augmentation of yield which, according to M. Guillon, an eminent refiner who first employed this process in his factory, considerably exceeds the ordinary amount.

The alkaline and earthy sulphates, particularly the sulphate of lime, do not exist, or exist only in very small quantities in the juice of the beet-root. The last-named salt, which is frequently met with in considerable proportions in the crude sugars extracted from that root, is introduced during the process of "carbonatation" in which the lime added to the juice is separated by carbonic acid. This gas is generated by burning limestone with coke. It often contains sulphurous acid as an impurity that forms sulphites, and these are eventually transformed into alkaline and earthy sulphates.

CURIOUS SEPARATION OF SILICA FROM SUGAR SOLUTIONS.

BY S. DANA HAYES,

State Assayer for Massachusetts.

A silicious deposit ("scale") recently accumulated on the copper steam-pipes of the vacuum pans, at one of the sugar refineries in this vicinity, in sufficient quantity to discolour the refined sugar by becoming detached and falling into the syrup. It forms only when "melado" crude sugar, a mixture of molasses

and grained sugar, is used in the refinery, and is deposited much thicker on the lower steam-pipes than on the higher ones, although all of them are covered by syrup during the evaporations.

These scales are laminated, almost crystalline, opaque, but not uniform in colour, the under sides being nearly black, while the upper sides are white or light brown, and when they are pulverized the resulting powder has a yellowish-brown colour. They are insoluble in boiling acids, both before and after calcination; carbonaceous matter and water are burnt off without material change of colour, when they are heated to redness for some time, but they yield no moisture when at 212° Faht.

One hundred parts of the pulverized scales yielded by analysis—

Silica	78·68
Copper oxide	5·05
Lime	1·38
Magnesia	0·48
Water and carbonaceous matter ..	14·41
	100·

The material is thus *practically* so much insoluble silica separated from the syrup.

But it is remarkable that the minute proportion of silica present should pass through all the previous processes of the refinery, where lime is added, filtering through bone coal, etc., and then be partially precipitated from the clear sugar solution in the vacuum pan at temperatures which never exceed 200° Faht. And also that the first portions of silica deposited should combine with copper oxide on the pipes, forming a compound insoluble in boiling nitric acid.

The proportions of soluble silica are variously given as being, in—

Sugar	between 0·029 and 0·288 per cent.
Molasses	,, 0·030 ,, 0·091 ,,
"Green" scum separated from cane juice ..	14·000 ,,
Sugar cane	0·200 ,,

American Chemist.

SUGAR MACHINERY.

From "*Iron.*"

(*Continued from page* 83).

The draining and drying of the sugar, for the separation of the molasses, after it has been cooled in the cooler is the last stage, in which improved mechanical appliances have advantageously superseded the old crude process of permitting the molasses to drain out of the sugar by the slow action of gravitation. The machines now employed are centrifugal, and consist of a cylindrical case containing a revolving basket or wire cage, caused to rotate at great speed, up to 1000 or 1200 revolutions per minute, of which the action will be readily understood; the fluid molasses are thrown off by the centrifugal force and drain out of the case, proper appliances being provided for their removal; the drained sugar remains in the cage, and can be lifted out and emptied from the top. These centrifugal machines are made in various forms, according as the axis of revolution is horizontal or vertical, the motion imparted by independent prime motors, belts, gearing, or friction wheels, applied to the top or the bottom. The periphery of the cage or basket is formed of finely perforated copper-sheets or wire gauze. For the complete removal of the last tenacious particles of molasses, it is advantageous to employ a steam jet with the centrifugal, or to wash with a little clean water.

When a number of centrifugals are ranged side by side and worked together, they are driven by an intermediate shaft and counter gear, either by fast and loose pulleys and bevelled gear, or by a belt to which a quarter twist is given; the latter arrangement is that shown on the plan, Fig. 2; it requires careful workmanship, and to be well fitted together and erected, otherwise the belts are apt to run off, but when in motion there is no noise, and little wear. The driving gear, when placed over head, necessitates friction or bevil wheels; and it may likewise be actuated by belting from an intermediate shaft, or by an independent vertical steam-engine, bolted on to the side of the machine, in which case the horizontal shaft becomes the crank shaft.

The foregoing are the chief mechanical appliances and processes connected with the sugar-manufacture; but there yet remain to be noticed some mechanical aids which are not entirely unimportant, with reference to the purification and clarifying of the cane-juice, at an intermediate stage. The first of these is the filter-press of Du Rieux and Roettger, as manufactured by Messrs. Manlove, Alliott, and Co. It consists of strong wrought-iron rods, uniting powerful end frames, and carrying by means of lugs a series of intermediate filter-frames, generally twelve in number, which are free to slide to and fro on the rods. The filter-frame is made of a plate of iron grooved on each side, and fitted with projecting flanges and a central orifice; the grooves communicating throughout with a pipe and cock for running off the filtered juice. Perforated plates rest upon the grooves, within the projecting flanges of the plates, and carry the filtering cloths so arranged as not to cover or close the central opening, but to cover the flanges. The filter frames, ranged side by side, touch only at the projecting flanges, gripping the filter-cloths between them, and the joint is made tight by a ring of vulcanised india-rubber. Into the space between the grooved plates of the alternate frames, the cane-juice to be filtered is introduced by a central aperture in the end frame, passing from frame to frame from the central openings from end to end. The filter-frames are kept tight and close up against each other by a powerful wheel and screw; and the juice, under pressure, percolates through the filter-cloths and perforated plates, into the grooves, whence it can pass freely away, leaving the impurities behind in the spaces between the frames: these can be cleansed readily by relaxing the screw and separating the frames.

No purely mechanical filters, however, can do more than remove solid impurities; but if it be desired to alter the colour, recourse must be had to animal charcoal. The charcoal filters are ranged side by side, in sets of say six in number, being simply cylindrical vessels filled with animal charcoal, and fitted with a grating covered with a filter cloth at the bottom, an outlet pipe and cock, and a series of three pipes whence they can be filled successively with syrup or cane-juice for filtering, and water for washing out.

After continued use the charcoal becomes clogged with impurities, and it is then necessary to cleanse, purify, and revivify the same. There are various methods of doing this, viz., by dry fermentation in warm and moist heaps, wet fermentation in warm water, and simple washing in cold water of medium degree of hardness. But the best and most effectual process of revivification is by burning the spent charcoal over and over again in kilns specially prepared for the purpose: one of the best modern arrangements of this kind is the pipe-kiln, as constructed by Messrs. Manlove, Alliott and Co., wherein the char is spread and partially dried on a plate at the top of the kiln, heated by the combustion products from below, and then is passed through drying tubes (passing through the flue) into vertical oval pipes set in the furnace of the kiln, where it is reburnt, and thence passes into a continuation of cooling pipes below the bed of the furnace, whence it is removed for use.

In conclusion, we have but little space to devote to a brief notice of the Bloomsgrove Works themselves, which are admirably compact and well arranged, from the foundries to the erecting shops, and from the drawing office and pattern shops to the packing department. The works, which cover some four acres of ground, are entirely self-contained, receiving the raw materials of various kinds and converting them, from the initial to the final stage, into the excellent and well adapted machinery which we have hereinbefore described. It is almost a work of supererogation to observe that, from the smallest to the most ponderous of machine tools and mechanical aids and appliances, this large and important industrial establishment is thoroughly and completely fitted up and equipped upon the most modern and improved designs, for the complete development and working out of every detail of the speciality for which the firm of Manlove, Alliott, and Co. are well and widely known and reputed, namely, the design and construction of machinery and prime-motors of every kind employed in the manufacture of sugar. Indeed, on the occasion of our inspection we saw examples of every portion of the plant of sugar-machinery, which we have described, in various stages of completion. We may remark that the general plan of sugar-works (Fig. 2), which

is one of our illustrations, is a fac-simile of the work as actually executed by them for an extensive factory, for which they have designed and erected the entire machinery, buildings, and plant: the dimensions of the cane mill are 7 feet in length, the larges and heaviest made, and the two vacuum pans (copper with cast-iron steam-jackets) are respectively 8 feet and 7 feet in diameter. Another factory, also recently fitted up by this firm, has two 6 feet mills working side by side.

We might devote a special article to a description of the Bloomsgrove and Rouen Works of Messrs. Manlove, Alliott, and Co., our inspection of which was eminently full of interest, and of the processes of industrial work and manufacture there carried on, but we have more than exceeded our present limits, and therefore content ourselves for the present with remarking that these establishments combine all that knowledge and experience, aided by capital, energy, and skill can effect in perfection of design and workmanship of the resulting products.

MAKING SMALL QUANTITIES OF SUGAR.

By Mr. Scott, Brisbane.

(Continued from page 42.)

Tempering (applying lime to the liquor).—I will premise that the operator has only four gallons of liquor; for this take ten or fifteen grains good quick lime; dissolve it in a pot or tumbler, with a portion of the liquor; after mixing it well, pour about one-half of it into the mass intended to be boiled into sugar. Stir it well. After it has settled, if it be slightly curdled—that is, into small detached particles—it is enough. If not so affected, add another half of the residue, and examine as before stated. If not then curdled, keep on adding small portions of the liquid lime until the curdle is to be seen. If the liquor should be too heavily tempered, it will show the curdle in large masses, and assume a yellow colour; in such case it is destroyed, unless such excessive tempering be reduced by adding raw (untempered) liquor.

Boiling of the Liquor.—This operation ought to be affected as rapidly as possible, during which all skimmings must be taken off. When evaporated into a small compass, remove it into a proportionably smaller vessel; and when it becomes so far densified as to drop from the skimmer or ladle in flakes, or to form a small thread, immediately lessen the heat to one-half or less—that is, no greater than what will be sufficient to keep it on a slow boil, testing its density every minute, thus: Place a drop of it in a cold draught, and when cool apply the index finger on it, to which close the thumb, and gently separate them; if, by so doing, no thread appear between them, it proves that the sugar is not sufficiently boiled. Thus test the boiling sugar twice every minute, until it makes a thread two inches long before it breaks; then instantly remove it into a cooler, where it may lay at least one inch and a quarter thick; and if the operation be skilfully performed, it will granulate in less than two hours. If this test be applied to cane juice, marking, as it does in this colony, ten and a half and eleven degrees Baumé's saccharometer, the sugar should be taken off the fire when the "thread" draws only one inch. This test of tempering applies equally to both. It is here necessary to note, that farmers making their own sugar by these instructions, if they have not a stove upon which to carry out the operation herein described, must have their pots roughly set, either with brick or stone, so that the upper portions of them are not exposed to the action of the fire, otherwise failure will ensue—their sugar will be black. An expert boiler needs none of these guides; his only and unerring guides are his vision and his nasal organs. For novices, instruments and chemical tests are useful to protect them from fatal errors; but they are far from being efficient, while these simple rules now offered will be found easy of application and safe. Their first essays may not prove satisfactory, but a little practice will soon qualify them. I send herewith a sample of sugar made by this new plan, and from canes recently flooded and immature. I do not think that I could have made otherwise than low ration sugar from them had they been treated agreeably to the present, I advisedly say, very destructive plan, as their juices

marked only nine degrees Baumé's saccharometer. These facts furnish to the reader a plain index that the culture of the cane for the production of sugar in this most favoured zone will shortly become one of our most valuable products. P.S.—I have herein omitted to state that the boiled canes can again be re-boiled with fresh water, but with a decreased profit of about seventy per cent. The first syrup must not, however, be delayed for the second.

PERFECT GAS-HEATING BY COMPLETE COMBUSTION AND UNDER CONSTANT VOLUME OF THE BURNT GASES.

(Continued from page 88.)

I.

Theoretical Considerations Establishing the Economic Importance of Heating under Constant Volume.

CHAPTER I.

General Ideas on the New Systems—Nature of Matter—New Definitions of Density and of Specific Heat—Laws which connect them.

XIII.

The new system of heating that I am about to develop theoretically and practically comprehends two parts—the one resting on the application of new principles, the other arranging various improvements applied to ordinary gas-heating, The whole forms a complete mode of procedure applicable to all branches of industry, having for the most striking result the suppression of the chimney, and bearing in fine the heading:

Economical Heating by Complete Combustion and under Constant Volume.

This new procedure essentially consists in reducing to gas all the fuels hitherto employed in their natural state, solid or liquid.

This reduction takes place in a gasometer of special form, blown by a ventilator and a steam-jet.

A part of the first heat of combustion of the coal will be utilised by the decomposition of a certain quantity of steam.

From the gasometer the gases will return by a short lead to the blast-pipe where their sensible heat will utilise another part of this first heat. A third portion will be employed in heating the feeding air of the gasometer, and at length the fourth and last portion will be utilised by the vaporisation of the water found at the bottom of the grate, and in which the slag and cinders will be extinguished.

The air-current of combustion in the blast-pipe will be cold or hot, as desired.

The burnt gases and the flame will be diffused under their heating capacities; then their last heat will be removed by bubbling in the water of a machine I call *hydraulic regenerator*, I will soon describe why, and in this manner will only retain at their exit the temperature and pressure of the surrounding air.

We will soon see also that the application of this regenerator will have the effect of forcing the combustion to take place under constant volume of the burnt gases, and the following considerations go to prove its utility and necessity.

. Before approaching the detail of the question, and in order better to particularise the fundamental points on which the practical dispositions that I employ rest, I am about to point out in a few words the various principles which form a part of the theory by which I am inspired for the establishment of my apparatus.

The application of these principles conduct:—

1st. To the employment of ordinary economical gas-heating, already several times attempted, but with arrangements and improvements of detail allowing of the realisation of the greatest possible useful effect in the employment of a given weight of fuel.

2nd. Besides these improvements of detail which lie above all in the combustion apparatus, and which already allow us to obtain a considerable economy, I obtain another important saving, of which the realisation, quite new, and forming the subject of a patent, rests on the practical application of theoretical principles, for the most part new, and which, in any case, have not been hitherto arranged in such a manner as to constitute a body of doctrine and produce appreciable practical results.

These theoretical principles are in all points at one with the new mechanical equivalent of heat really settled by the writings of various eminent physicists who have treated this matter.

I will provisionally consider how far we may follow as exact the various determinations of specific heats, densities, &c., made by M. Regnault, one of the most able experimenters, and I am obliged, in order to speak with certainty of the new arrangements necessary to the economy of fuel, and to show their value, to say a few words on the state of the matter.

XIV.

Bodies, however they appear to us, let us name them simple or compound, only contain, for me, a single and unique matter, comprising two orders of molecules capable of having, or not having, form. I will call them *morphous* and *amorphous*. They cannot expand.

The first are capable of crystallising in different ways. By their agglomeration under different forms in different quantities, they constitute the different natural bodies.

When we break the state of aggregation of these molecules by the application of a force more powerful than that which unites them, we produce what we call a physical phenomenon, if the rupture is only a widening of the distance of these molecules, the one from the other, or what we call a chemical phenomenon if we place it before molecules crystallised in a different manner, and able by their union or their disjunction to arrange themselves otherwise, and so produce a new crystallisation.

Simple force, the sole cause of all the phenomena of movement which appear to us in the universe, dwells in the morphous molecules under the name of attraction. Between these crystallised molecules, capable of being weighed by us, are intermingled other molecules imponderable for us of extreme fluidity, and which, in their entirety, have received the name of *cosmic matter*, or *ether*. To me, these molecules are not capable of crystallisation; they are amorphous.

The cosmic matter is of extreme fluidity. I liken it in nothing to the heat of which it is simply the medium, for caloric is only a

movement of these amorphous molecules, or, as we still say, of the ultimate particles of matter.

So, then, the primary creative impulse admitted, all the phenomena of the physical world will rest on the evolution of these molecules, morphous and amorphous, obeying actions exercised upon them by simple force, capable of showing itself to us under the form of heat, light, or electricity.

I am now about to study rapidly two orders of ideas needful to the understanding of my subject, *specific heat*, *internal molecular action*.

Caloricity, or specific heat, in the ordinary language of the physicist, only represents *apparent caloricity*.

M. Hirn, in his very remarkable work, called "Mechanical Theory of Heat," says:—

"What we have called hitherto calorific capacity is a variable "one, since the heat added to the bodies in the experiments made "to determine it is not solely employed to modify the temperature. "The absolute capacity is the quantity of heat required to increase "by a thermometric unit the temperature of the unit of weights; "this capacity is then for him a constant one, that he calls K."

My definition is not the same; I press the analysis further, and I call:

Real caloricity, the quantity of heat required to raise by a thermometric unit the temperature of the unit of volume of cosmic matter.

So that, if I denote by y this quantity that I consider, be it understood, as constant for all bodies, if on the other hand u is the quantity of cosmic matter contained in the unit of weights of the body taken at the temperature of 0°, for example, I will have, between the number of M. Hirn and these two new quantities, the relation:

$$K = yu.$$

Since I have just said that cosmic matter was imponderable to us, it follows that the more of it a body relatively contains, the less will be its weight.

From which it follows that the density of a body is given by

the connection that exists between the number of morphous molecules and the number of amorphous molecules contained in the unit of weights of this body at a fixed temperature.

If m and u are these two values, we shall have :

$$d = \frac{m}{u}$$

We reach at once this second definition :

The density of a body relatively to another body, of which the density is taken as unit, is given by the affinity of the cosmic fluid contained in the unit of weights of the second, to the cosmic fluid contained in the unit of weights of the first, both being taken at the same temperature.

For if d', u', m' are the related values of the first body, d, u, m, those related to the second, of which the density is taken as unit, if, further, we consider always the unit of weights the non-expanding morphous matter is found in the same quantity in the two bodies, and we have $m' = n$, consequently by applying the first definition :

$$d' = \frac{m}{u'}$$

From which we derive, by dividing :

$$\frac{d'}{d} = \frac{m}{u'} + \frac{u}{m} = \frac{u}{u'}$$

And as by hypothesis $d = 1$ we have finally :

$$d' = \frac{u}{u'}$$

We will see further on this definition strictly confirmed by the figures furnished by the present state of science.

As I have said before, the application of heat to any body whatever is not capable of expanding the morphous or amorphous molecules of this body. Their volume is immutable; they only spread out, more or less, the one from the other.

Without insisting further, I will say that this assertion is not an hypothesis, it is rather an axiom to me; for to allow of the expansion of any molecule whatever, would be to admit the existence of a vacuum in the material world, to which our reason refuses to listen.

If, then, we heat a body, what does it produce? The cosmic matter interposed between the morphous molecules commence vibrating with an increasing intensity, it is the medium of the force manifested under the form of heat, the morphous molecules move apart, the vacuum thus produced among them is at once filled with new molecules of cosmic matter—in a word, according as the heat produces its effect the quantity of cosmic matter contained in the body goes on increasing. Consequently the considered weight of this body increases in volume—that is to say, that for the same quantity of morphous matter it contains a greater proportion of cosmic matter, or, in other terms, the density has diminished agreeably to experience and to the definition before given.

The inverse is produced when we contract the body in question. The consequence of the foregoing definition will be that *the real and apparent caloricities of bodies ought to increase when we expand them and diminish when we contract them.*

Let us see and establish strictly this fundamental proposition for the subject treated in this sketch.

I have already said that the recorded specific heats in the tables did not represent the true caloricities, since the calculated heat is not alone employed in altering the temperature.

If, then, I denote by Cp the specific heat in weights at constant pressure from the tables, by i and e the quantities of of heat devoted to internal and external action during the expansion of the body, I will have, leaving out radiation :

$$Cp = yu + i + e.$$

At first sight we see that if we leave the body to expand freely i diminishes, as I will establish further on, but e increases, and yu increases, because u expands; it follows that Cp increases, because i, above all in gases, is small relatively to the other quantities.

But, besides, let us observe that all the determinations of specific heats made till now show that Cp increases in proportion as the body expands.

The co-efficients of enlargement even have been calculated for several solid bodies. It is thus that for iron the calorific capacity

increases per degree, or by enlargement of volume, corresponding to a degree of 0·0000595. M. Regnault has found that the caloricity of carbonic acid, being 0·187 at 0·, becomes 0·2396 at 200°; that that of air, being 0·23727 at 0, becomes 0·23783 at 200° when these gases are allowed free expansion.

As to water, its caloricity, being 1 at 0, becomes 1·0204 at 230° in the same conditions.

In following the same order of ideas, we are led to establish that *for a body itself the specific heat will be as much stronger as the density of that body will be weaker.* Experience has again verified this mode of viewing it:

It is thus that the caloricity of liquid bronze being 0·111, that of solid bronze is only 0·084. It is the same with liquid mercury, of which the caloricity is equal to 0·0333, and at the solid state equal to 0·0319.

Apparent caloricity also increases, above all at the moment when the body commences to soften, and in general it is greater in the gaseous state than in the liquid state, and in the liquid state than in the solid.

In fine, if we examine the table containing the densities of bodies, and look at their specific heats, we understand that the apparent caloricity is as much greater as the density is weaker.

The lightest body known, hydrogen, and the heaviest, platinum, fully confirm this law, their specific heats being respectively equal to 3·4046 and 0·03243.

These figures, which I will not multiply, causes us already to consider as likely the proposition made above, and of which what follows strictly goes to prove the certainty.

Indeed, if the definition which I have given of density is exact, and which I denote by d, d', d'', &c., u, u', u'', ... the densities and the quantities of cosmic fluid enclosed by different bodies, and I will only occupy myself at first with the gases which interest us, I will have the relations:

$$\frac{d'}{u} = \frac{u}{u'} \quad \frac{d''}{d} = \frac{u}{u'} \quad \frac{d'''}{d} = \frac{u}{u''} \text{ &c.}$$

Or what comes to the same thing;

$$\frac{d'}{d} = \frac{yu}{yu'} = \frac{k}{k'} \quad \frac{d''}{d} = \frac{yu'}{yu''} = \frac{k}{k''} \quad \frac{d'''}{d} = \frac{yu}{yu''}, = \frac{k}{k'''}$$

Remembering that k, k', k'', k''', &c., are the absolute capacities determined by M. Hirn.

Now M. Hirn finds, by calculation, that these various absolute capacities are respectively:

For Hydrogen $k = 2{\cdot}4448 = yu$
,, Oxygen $k' = 0{\cdot}15 = yu'$
,, Nitrogen $k'' = 0{\cdot}17143 = yu''$
,, Carbonic oxide $k''' = 0{\cdot}17143 = yu'''$

If now we take for the densities of these various gases in relation to water the figures determined by M. Regnault, and which are:

For Hydrogen $d = 0{\cdot}000089578$
,, Oxygen $d' = 0{\cdot}001429802$
,, Nitrogen $d'' = 0{\cdot}001256167$
,, Carbonic oxide $d''' = 0{\cdot}0012505$

We find: $\frac{k}{k'} =$ sensibly 16

$\frac{d'}{d} =$,, 16

We can then write $\frac{d'}{d} = \frac{k}{k'}$

Then $\frac{k}{k''} =$ sensibly 14

$\frac{d''}{d} =$,, 14

Again $\frac{d''}{d} = \frac{k}{k''}$

In fine $\frac{k}{k'''} =$ sensibly 14

$\frac{d'''}{d} =$,, 14

Then $\frac{k}{k'''} = \frac{d'''}{d}$

These very remarkable results prove two things:

First, that my definition is exact as well as the deductions which flow from them, then to the honour of French science that the figures of M. Hirn for these gases, as well as those generally received for the densities are very nearly exact. If I bring these various results together, then, I find that we have:

$$du = d'u' = d''u'' = d'''u'''$$, &c., constant.

Which can enunciate:

The product of the density of a gaseous body by the quantity of cosmic fluid contained in the unit of weight of that body is constant.

Or in other terms:

When we cause the density of a gaseous body to vary, its real caloricity varies in an inverse sense, and consequently as a direct cause of its variation of volume.

This is the theory we wish to demonstrate.

I will not seek to establish that this theorem is general and applicable to all the bodies in nature; that would lead me too far from the subject treated here, where we have only to consider certain gases.

Now let us see to what practical conclusions the settlement of this theorem leads us:

And first, what happens when we apply a certain quantity of heat Q to a given weight of gas P?

This heat divides in several portions:

1st. That communicated to the surrounding cosmic matter, under the form of *radiation*, and which will be Qr.

2nd. That used in producing what is called *external action*, and which acts upon neighbouring bodies, under the form of pressure—for example, in the cylinder of a steam-engine—and which will be $Q\,ex$.

3rd. That employed to destroy the attraction which joins the morphous molecules, producing what is called *internal molecular action*, and which will be Qi.

4th. That employed in the *increase of temperature*, showing itself on the thermometer, and which will be Qt.

We shall have then: $Q = Qr. + Qex + Qi + Qt$.

Now I suppose the two following cases, that the burnt gases could or could not expand freely.

In the first, which is the usual case, the apparent and real caloricities, as I have previously shown, increase.

They were, for example, C and c, at the temperature of starting, which I will suppose to be o, for more simplicity, they are become C', and c at the temperature reached, which will be t'.

I have then in the first case :

$$Q - Qr = Qex + Qi + Qt'.$$

Now : $Qt' = Pc' t'.$

But we have also, for the apparent caloricity includes with Qt' the heats Qex and Qi.

$$PC't' = Qex + Qi + Qt' = Q - Qr.$$

In the second case, I suppose that by the application of my hydraulic apparatus, described further on, the volume of burnt gases remain constant. We see, then, that

$$Qi = o.$$

As to Qex, I allow that to my disadvantage it has not decreased, and that is partly true, for that heat has productive action to be measured by the column of water raised in the apparatus, in such a manner that in this second case I have :

$$Q - Qr = Qex + Qt = PCt$$

t being the new unknown temperature reached in the second case.

Further $Qt = Pct$

for C and c have not varied. We deduce from that :

$$t = \frac{Q - Qr}{PC} = \frac{Qex + Qt}{PC}$$

And $$t' = \frac{Q - Qr}{PC'} = \frac{Qex + Qi + Qt'}{PC'}$$

We see at once that t is greater than t', for the numerators being the same we have :

$$Pc < Pc'$$

then $$c' > c$$

then finally $$t > t'$$

I will formulate this fundamental proposition.

If we compare two firings made, the one at a constant volume, the other at a variable volume of burnt gases, the temperature produced in the first is superior to that produced in the second, all other things being equal.

In examining closely the preceding formulas, we understand that this increase of temperature is due to two causes—first, the *non-increase of the real caloricity*, then *the non-production of internal action*. Let us hasten to say that for the permanent gases this last cause influences less relatively to the first, but we ought still to take note of them, for in the burnt gases is found a very noteworthy proportion of carbonic acid, and even also of steam, for which bodies the internal action is far from being to blame.

If we seek to give ourselves an account of the practical importance of this increase of temperature, we are stopped at the threshold by the want of data. We have only at our disposal the apparent caloricities determined by M. Regnault, and their increase as far as 200° for carbonic acid and nitrogen.

It is necessary for us to know exactly the real caloricities, their increase, and the values of the internal action from degree to degree. My experiences and my calculations on this subject still require completion, and I will only publish them later and elsewhere.

At all events, it remains clearly proved, after what has preceded, that the apparent and real caloricities of the gaseous bodies increase in proportion as these gases are allowed to expand. If, as a first approximation, we apply the co-efficients of increase found by M. Regnault, and which, for air, are equal to 0·0000028, and for carbonic acid to 0·000263, by an increase of volume corresponding to a rise of 1° centigrade, and if we calculate, by means of the preceding formula, the values of t and t', giving for Q the quantity of heat disengaged by the combustion of the burnt gases, and for P the weight of the burnt gases arising from this combustion, we find between t and t' a gap of more than 500°, which would carry the gain of temperature due to the non-expansion of the burnt gases to about 25 per cent. of the theoretical temperature.

And do not let us misunderstand, that is not a creation of new heat, *it is only a regeneration, we force to show itself in a sensible and utilisable state, a heat which remained hitherto in the latent state.*

I will stop there these discussions upon caloricity, to say a few words on internal molecular action.

CHAPTER II.

Considerations on Internal Molecular Action.

XVI.

We have already seen that without being *nil* for the permanent gases, it was weak relatively to the values which it reached in the denser gases, in the liquids, and, in fine, in the solids.

Whatever it might be, I have also proved that it showed itself when the gases under consideration were allowed to expand freely, and that to prevent this expansion was to obtain thereupon a very important useful result.

Let us take up again, at this point, the examination of passing phenomena, for example, when we heat a solid body. We have seen that this application of heat, in causing the morphous molecules of the bodies to separate themselves, allowed an increasing proportion of cosmic matter to lodge between these same molecules, that consequently the real caloricity increased with the volume, but at the same time this matter, or cosmic fluid, has exercised, in consequence of its vibratory movement, a series of tensions on the morphous molecules and the foundation of the body. If we continue the action of the heat, the cosmic fluid increases more and more in the body, its morphous molecules estrange themselves still more and more from each other, and it soon arrives at vaporisation.

To arrive at this result we shall have expended a certain number of heat units, having produced an action that we call interior molecular, and which has had for successive effects first fusion and then vaporising.

That if we continue to heat it still, the force thus put in play will be sufficiently powerful, in many cases, to act on the crystallisation even of the morphous molecules, to disunite them, and produce in consequence what we call chemical decomposition.

I have said previously that I looked upon all bodies in nature as simply obtained by aggregation according to different arrangements, of morphous molecules crystallised in different manners, and separated by the interposition of a more or less large quantity of cosmic matter.

These combinations of crystals, in their infinite number, form the immense variety of bodies in nature. If we set aside infinite forces or heats, in conformity with our smallness, we will arrive at isolating the elementary molecule, and be able to study the various forms that it is capable of taking. To reach that point experimentally appears to me impossible to many, but the calculation is there, and when we will be well satisfied that we cannot settle higher chemistry without the help of geometrical analysis, we will have approached the goal.

We have not yet any certain data for valuing strictly the internal action.

In this research we ought, I believe, to apply Newton's law of attraction. We possess an element of internal molecular action, it is the road passed over, the co-efficient of expansion, *a* with this restriction, at the same time, that the value that we measure is a minimum on account of the external action exercised on the surrounding bodies.

Now, if my definitions are exact, the true expansion of a body will be as much greater by a degree, that is everything otherwise being equal, for a similar quantity of applied heat, as the body will be less dense, that is to say, will contain, for a similar weight, more cosmic matter, or that its morphous molecules will be more estranged the one from the other.

If my hypothesis, if the deductions that I have drawn from them are true, the values already known of the co-efficients of cubic expansion ought to corroborate the following law:

The true expansion of a body per degree is greater in the gaseous state than that of the same body in the liquid state, than that of the same body in the solid state.

And I will say more generally:

The co-efficients of expansion of gases ought to occupy the first rank, then come those of liquids, then those of solids.

And that, because in proportion as the morphous molecules of a body separate outwards from one another, in liquifying it, then vaporising it also in proportion, the attraction which binds these molecules varies in an inverse ratio to the square of the distances

which separate them, that, consequently, that attraction diminishing, the quantity of heat required to conquer it diminishes also, that in consequence, in fine, the effect produced as expansion, by a similar quantity of heat, is greater and greater, and that this effect being approximately represented by the co-efficient of cubic expansion, it follows that this co-officient ought to go on increasing in proportion as the body advances from the solid state to the gaseous state, or, in other terms, in proportion as its density diminishes.

The data of experiment fully confirms what precedes.

In general the co-efficient of the gases being on an average equal to 0·00367 per degree, that of liquids does not go beyond 0·0011 for alcohol, the weakest among them is equal to 0·000156 for mercury—that is to say, the densest, the least liquid, if we may thus express it. The co-efficient of highest cubic expansion for solids does not go beyond 0·000093 for zinc; the weakest is that of platinum, equal to 0·000027.

In fine, in the same body, at different temperatures, I find, after Dulong:

Mercury, from	0 to 100		0·00018018
,, ,,	100 to 200		0·000184331
,, ,,	200 to 300		0·000188679
Platinum	0 to 100		0·000026526
,, ,,	0 to 300		0·0000826446
Iron ,,	0 to 100		0·000035463
,, ,,	0 to 300		0·000131584

These various figures show that the co-efficient of expansion increases with the temperature, in so far as it produces an increase of volume.

Let us make once for all this restriction, that is, that in the gases the co-efficient a diminishes when the density diminishes. That does not at all weaken what I have been saying, for in this case a is above all the function of external action. Now we know that this last action increases with the volume; it follows that the quantity of heat required to perform it increases, that consequently the effect produced as expansion by a similar quantity of

heat is weaker and weaker, and that this effect, in this case, being represented almost completely by the co-efficient *a*, it follows that this co-efficient ought to go on diminishing with the density of the gas.

Let us add that this last effect is still more striking when we determine this co-efficient in the gases submitted to a greater and greater pressure. For it is clear that if we compress the gas in experiment, that is to say, if we force the morphous molecules to approach each other, then, as we seek to expand them, we are obliged to develop an internal molecular action greater and greater, the quantity of heat possessed by the body being taken as constant in this case, the product increasing, one of the factors being constant, it follows that the other, which is the co-efficient of expansion, increases, and that is what M. Regnault has found.

This *savant*, in fine, has settled that the co-efficient *a* for carbonic acid was for a pressure of 1 metre of mercury equal to 0·0036686, and at 0·0038057 for a pressure of 10 metres of mercury.

The conclusion from all that precedes is that:

If we allow the burnt gases to expand freely, and their initial pressure to diminish, there is absorption in the latent state of a quantity of heat not yet very exactly determined, but which I have shown to be important. If, on the contrary, we oppose this expansion, this heat will appear in a sensible state.

Let us see by what practical means we can arrive at producing a combustion where the burnt gases will not be able to expand freely.

(*To be continued.*)

THE EDIBLE STARCHES OF COMMERCE, THEIR PRODUCTION AND CONSUMPTION.

By P. L. Simmonds.

The production and consumption of edible starches have now attained very large proportions. Unlike the French, who have two words which they apply, with different meanings—fecula and

amidon, or starch,—we are, in a great degree, limited to one, all being essentially starches in commerce, even with the minor classifications of arrowroots, sagos, tapiocas, corn-flours, etc.

The French confine the term fecula to the starch obtained from roots, such as manioc; of stems, as the sago; and fruits or seeds, as of the horse-chestnut, acorns, etc.; while the amylaceous product obtained from the cereals, which crystallizes, on drying, into needle-like forms, they define as amidon, or starch.

Very little has been published on this extensive and important branch of commerce—at least in a collected form, for occasional papers have appeared, from time to time, in various scientific journals. Perhaps, however, the best and most carefully conducted investigation into all the tropical starch-producing plants, their characteristics, and properties, was that carried out, about a quarter of a century ago, by Dr. Shiers, in British Guiana, and published locally in a pamphlet.

It is not my intention to trouble you with scientific and chemical descriptions of the special characters of the starches from various plants, or to treat upon the mooted question of how far they furnish nutritive food,—subjects which fall more properly within the scope of Societies like the Microscopal, the Chemical, the Pharmaceutical, the Medical, etc. I shall restrict myself to the commercial aspect of the question. I may, however, state that I have placed on the table a very large and varied collection of edible starches, which have all been carefully identified and referred to their proper sources by my friend in the chair, for in commercial circles there is too much confusion on this point. A few figures will serve to prove that the commerce in these articles is of considerable aggregate importance.

In 1850, we imported about one million pounds of arrowroot; in 1860, these imports had increased to more than 2,383,000 lbs. In 1860, the value of the edible starches, etc., imported was £206,438. In 1870, it had increased to £366,550.

In 1871, the last year for which we have the complete official detailed returns of imports, the aggregate value of the farinaceous substances and manufactures therefrom imported is stated at

£274,281; sago and sago flour, £197,381; total, £471,662. But as the article "maizena" is thrown in with Indian-corn meal, and much maize, rice, and even potatoes are converted into edible starches here, I may as well add the figures given for Indian-corn meal (£13,944) to the above, which would bring up the total to £485,706 for the year.

Our imports of arrowroot from the West Indies, in the last ten years, have fluctuated between 12,000 cwt. and 22,000 cwt. a year; from South Africa we now get from 3000 to 4000 cwt. annually.

Having thus given you an outline of the extent of our imports, I proceed to treat of the production and consumption in the several localities, preferring to arrange the information under these divisions, as more generally recognizable, and more easily followed.

European Starches.

But few plants are utilized for edible starches in Europe. We are mainly dependent for our supplies of these on tropical and sub-tropical countries. Occasionally small quantities of Portland arrowroot have been made from *Arum maculatum*. In Italy the fecula of *Arum italicum* and of *Pancratium maritimum* is manufactured to some extent, and sold at 3½d. per lb. About two tons are made annually by one maker at Cava.

Starch is manufactured in the South of France and the neighbourhood of Paris from the horse-chestnut. It yields about 16 or 17 per cent. of starch. If it is to be used as food, it must be treated with water containing carbonate of soda, to remove all bitterness, and then washed repeatedly with pure water. Only small quantities of it have been imported into this country, more for curiosity than for commercial purposes.

Rice starch has within the last few years been prepared as a beautiful food product, under the name of corn-flour, by an eminent firm, and the care with which it is manufactured, and its nutritive qualities have commanded for it a large sale. As much as 80 or 90 per cent of starch has been obtained from some kinds of dry rice, but the average may be taken at 73. Imported maize or

Indian-corn is also converted in this country into a starchy food product sold as corn-flour.

Under the name of farina, without the prefix of "potato," a large quantity of potato starch is imported and sold here. The process by which potato starch is now so largely made on the continent by improved machinery is very perfect. Its hygroscopic properties are however great; even when sold in the shops in the form of dry powder, as a substitute for arrowroot, it contains 18 per cent. of water, and if placed in a damp atmosphere, it will rapidly absorb double that amount of water. The percentage of starch in the potato ranges from 9 to 26 per cent. Sago, vermecelli and various other food products are made on the continent with potato starch. The famed gravies, sauces, and soups of France are largely indebted for their excellence to the so-called farina from potatoes.

As Professor Owen observed as far back as 1856, in his official report on the alimentary substances shown at the Paris Exhibition of 1855—"The French at present appear to excel in the art of preparing and modifying the starch principle of the potato, so as to simulate the product of the *Maranta arundinacea*, called under one form arrowroot, and under another or granular form, 'tapioca;' as also to simulate the starch principle of the *Cycas circinalis*, called 'sago,' and that of certain Asiatic species of *Orchis*, called 'salep.' It must be added that the conscientious fabricators of these imitations vend them as 'French' or indigenous 'arrowroots,' 'sagos,' etc., and at a lower price than that for which the genuine exotic article can be obtained. I am afraid that there is little conscientious principle manifested among vendors here, for European arrowroots and sagos sell as readily and promiscuously as Indian and American."

West Indian Arrowroot.

Marunta arundinacea furnishes most of the genuine West Indian arrowroot, although other species, such as *M. nobilis*, *M, Allouya*, *M. ramosissima*, are also cultivated for a similar starch from their tubers, and several species of *Canna* are utilized for the starch in their tubers.

The Bermuda arrowroot was long considered the purest quality made, its superiority either arising from the nature of the water or soil, or from greater care in the manufacture, but the production has been declining, and has now given way to other more profitable crops. The general export from the colony was, in 1870, 45,675 lbs.; in 1871, 30,276 lbs.; and in 1872, 26,710 lbs.; valued at £1323.

When made by the labourers in the West Indies on a small scale arrowroot is prepared much in the same manner as potato starch in this country for domestic use; the only implements required are a grater and wooden troughs and trays; when made on a larger scale, as on the estates of the proprietors, the crushing of the root and the reducing it to a pulp are effected by simple and cheap machinery (a wheel and rollers) worked by water. The arrowroot is dried under sheds. Little or no use is at present made of the pulp after the extraction of the starch by lixiviation, but probably a serviceable paper might be made of it at a trifling cost.

In 1869, there were 65½ acres under culture in Jamaica, and in 1770, but 49¼ acres. The exports have declined year by year from 70,204 lbs. to 6343 lbs. In the Island of St. Kitts, arrowroot and *tous les mois* (from Canna) are produced to some extent.

The amount of arrowroot exported from St. Vincent is now about two millions of pounds; in 1847, the quantity shipped was only 297,587 lbs.; and in 1851, 490,837 lbs. Many circumstances have promoted this increased culture. When it began the price of the article was high, and the grower obtained a largely remunerative profit; its culture was not laborious; it was subject to few risks; it did not for its success require rich land or much manure; there was a constant and increasing demand for it; and in consequence of the abundance of pure water, great facilities were afforded for the mauufacture, and that by a process so simple, easy, and cheap, as to require little skill in conducting it, and scarcely any capital. St. Vincent is the only arrowroot-producing colony that has kept steadily progressive.

I have not any recent statistics of the production of arrowroot in

Barbados, but I believe little is made or shipped from the island now.

In Antigua there has been considerable decline in the production. From 1850 to 1854 the exports were from 300 to 500 boxes and barrels, and from Montserrat, in some years, 250 barrels. In 1870 our imports of arrowroot from Antigua had dwindled to 30 cwt., value £28.

Tortola used to export arrowroot and *tous les mois* of the value of £500 to £1500 a year, but has dropped out of the production.

North American Starches.

The enormous production of Indian-corn in the United States, and the fact of its containing a less proportion of gluten than wheat have led to its extensive utilization for starch manufacture, and also as a food product, under the names of maizena and corn-flour. As an alimentary product this starch is gradually working its way in Europe, and has been rewarded with silver medals at several of the industrial exhibitions. Maize contains about 75 per cent. of starch. A considerable quantity of Maranta starch is produced on the coasts of Georgia and Florida. The yield of roots of all sizes is from 100 to 150 bushels per acre. From a bushel of roots weighing 43 lbs., about $5\frac{3}{4}$ lbs. of clear, dry fecula is obtained.

South American Starches.

In British Guiana a good deal of edible starch is made from the various tropical roots, but the starchy products do not form an article of export from the colony now, the arrowroots, cassavas, etc., being locally used. Palatable starch can be obtained from the root of the *Alstrœmeria pallida*, Graham, and the starch from the various Chilian *Alstrœmerias* was suggested to be sought for and shown at the exhibition of 1851. The tubers of many of these could doubtless be utilized in a similar manner. In Brazil considerable attention is given to the production and manufacture of edible starches. A most interesting and varied collection of these was shown at the Paris Exhibition in 1867; it comprised among others the following products, many of which I have not been able to identify, in the absence of either scientific name or other clue to the plants.

(*To be continued.*)

Correspondence.

ON GILL'S NEW PROCESS FOR PURIFYING CANE JUICE.

To the Editor of "The Sugar Cane."

Sir,

In your issue of 1st December I notice an article, headed "Explanation of Gill's New Process for Purifying Cane Juice," &c., &c., by W. Eathorne Gill.

Having carefully read said article, I find no explanation of the means by which the indicated advantages are to be obtained, other than you are told that by some means or other galvanism is produced by the sole action of the cane juice itself.

As I belong to the class of planters who are anxious to adopt any new method of improvement in the manufacture of raw sugar, I would feel thankful to Mr. Gill if he will state in what manner the public, or myself in particular, may reach the advantage of his discovery, either publicly in your journal, or by direct communication.

It is now four years since I adopted Fryer's Concretor on my estates at Viegnez, Porto Rico, and believe to have obtained all the advantages justly attributed to the system as far as regards yield, having attained an average of 1·98½ lbs. per imperial gallon of Juice 10° B. The advantage I now seek is an improvement in quality, which the discovery of Mr. Gill seems to warrant, or, at least, to promise.

C. M. Hjardemaal.

St. Thomas, W.I., 27th December, 1873.

Stocks of Sugar in the Chief Markets in the World on the 1st January, for Three Years, in thousands of tons, to the nearest thousand.

	1873.	1872.	1871.
Great Britain	184	99	122
France	197	85	132
Holland	29	25	14
Germany (Zollverein)	43	37	43
Six other *entrepôts*	8	5	4
Total in Europe	461	251	315

Consumption of Sugar in Europe for Three Years on the 1st January, in thousands of tons.

	1873.	1872.	1871.
Great Britain	798	715	662
France	276	224	327
Germany (Zollverein)	263	239	212
Holland	28	23	20
Six other *entrepôts*	104	95	113
Total in Europe	1,469	1,296	1,334

Estimated Crop of Beet Root Sugar on the Continent of Europe, for the ensuing Season, compared with that of the three previous Seasons.

(From Licht's Monthly Circular.)

	1873-74.	1872-73.	1871-72.	1870-71.
	Tons.	Tons.	Tons.	Tons.
France	400,000	259,000	189,000	263,000
Germany (Zollverein)	285,000	409,000	335,000	289,000
Austro-Hungary	175,000	214,000	162,000	182,000
Russia and Poland	150,000	150,000	90,000	135,000
Belgium	68,000	76,000	72,000	56,000
Holland and other Countries	37,000	35,000	25,000	17,000
Total	1,115,000	1,143,000	873,000	942,000

SUGAR STATISTICS—GREAT BRITAIN.

To February 20th, 1874 and 1873. In Thousands of Tons, to the Nearest Thousand.

	STOCKS.						IMPORTS.						DELIVERIES.					
	London.	Liverpool	Bristol.	Clyde.	Total, 1874.	Total, 1873.	London.	Liverpool	Bristol.	Clyde.	Total, 1874.	Total, 1873.	London.	Liverpool	Bristol.	Clyde.	Total, 1874.	Total, 1873.
British West India	14	3	1	19	37	28	8	3	1	4	16	9	13	1	1	4	19	19
Cuba	2	4	..	13	19	13	..	1	..	2	3	3	1	..	..	8	9	7
Porto Rico, &c. ..	..	6	..	3	9	5	..	3	..	..	3	2	1	3	..	..	4	3
Brazil	3	24	..	5	32	18	1	9	1	1	12	7	1	6	1	1	9	9
Mauritius	3	1	..	2	6	7	1	1	..	3	5	6	1	..	..	1	2	6
British East India	15	4	..	..	19	18	3	1	..	..	4	10	2	1	..	..	3	4
Manilla & Java ..	33	13	1	2	49	28	4	2	4	2	12	6	2	3	4	1	10	7
Beetroot, &c.	10	1	1	6	18	17	14	3	2	7	26	26	10	4	3	7	24	31
Total, 1874 ..	80	56	3	50	189	154	31	23	8	19	81	69	31	18	9	22	80	86
Total, 1873 ..	62	29	4	39	55 increase		24	15	9	21	12 increase		29	16	11	39	6 increase	

THE STATE AND PROSPECTS OF THE SUGAR MARKET.

The Sugar Market is at present in a very quiet condition, but this seems to be almost an abnormal one. We are at present in the balance, waiting to see what is to be done in regard to the Sugar duties.

Mr. Gladstone, with a good budget, large promises and with a nominal majority of sixty, felt himself compelled to go to the country, and the country has put him aside. Mr. Gladstone promised a great easing of the tax upon sugar, if not its utter abolition, but it is very doubtful what course his successor will pursue; although it is almost certain that he will not reduce at all events to any great extent, the tax upon a substance which brings such a large and ever increasing revenue to the Treasury, as is the case with sugar. The sugar industry is thus in doubt what is to be the action of the new Ministry towards it.

The fact of Mr. Gladstone having promised relief, to some extent, from the sugar duty, made an almost instantaneous change in the market. At the present time the production of refined is moderate, whilst stocks of raw are increasing. The demand is at present comparatively quiet, and the production is only keeping pace with that, we should imagine however that a change must soon come, when the policy intended to be followed by Mr. Disraeli becomes apparent.

We see from Mr. Licht's latest report that he has again raised the calculated amount of beetroot in France, for the ensuing year, a calculation a little at variance with the reports coming from that quarter.

The prices current are as follows: No. 12 Havanna afloat, for the United Kingdom, 24s. 6d. to 25s., against 27s. 6d. last year; fair to good refining Cuba Muscovados, 21s. to 22s., against 24s. 6d. to 25s. last year; middling to good brown Bahia, 17s. to 18s. compared with 20s. to 21s. 6d. in 1873; good to fine Pernambuco, 19s. to 20s., being a falling off of 2s. 6d. from the prices current at same time last year.

On the whole, we can only say the trade seems in a state of uncertainty, and no doubt will soon take a decided turn, when the views of the Government upon the sugar duties are known.

THE

SUGAR CANE.

No. 57. APRIL 1, 1874. VOL. VI.

☞ The writers alone are responsible for their statements.

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IS SUGAR A LUXURY?

"Fast find, fast bind" is a proverb that seems to have taken root in the mind of our new Prime Minister. Perhaps it may be hard to judge of his doings-to-be as yet; perhaps he means to astonish us soon by being more Liberal than Conservative; in fact, he may be finding out by experience that the true Conservatism is the true Liberalism, and that to keep the country ahead in the world's race—whether it be the race for power or the race for riches — requires a constant changing of working methods, of working theories, and by this means, although Liberalism is the slave, Conservatism is the master; Liberalism the working power, Conservatism the end attained, and that end being the keeping of our country amongst the foremost of the nations of the earth.

It is small deeds that make up great wholes. The repeal of the Income-tax may change the endeavours of the work of a Ministry, but it is upon only a certain portion, and that not a comparatively large one, that the weight of this tax falls. Numbers of men in medium positions in life feel this tax heavily, but the tax upon articles of food comes still more heavily upon these very men, and those who now call out loudly for the repeal of the Income-tax would be more than pleased if, instead of getting what they are now agitating for, they could obtain that great *desideratum* of our time—*free food.*

Many people, even in this country, are apt to talk loudly regarding the tax on luxuries. We do not complain of this.

Tax luxuries certainly; but let us first come to a decision as to what is the nature of a *luxury*. Few will deny that this definition changes with the changing prosperity of a country. Those articles of food which were luxuries in the reign of Elizabeth are no longer luxuries now. Tea, which, not very long ago, was only drunk by the very wealthy, and bought at an enormous price, now finds its way into the houses of our poor. The weed brought by Raleigh to England, and against which all kinds of maledictions were hurled, and which was taxed exorbitantly, is now so common that the percentage of non-smokers in this country is very small. And so we see the world keeps straight on in its progress. Money is more plentiful now than at the end of last century, and what were luxuries then can scarcely be called so now. And so before we can treat of a subject such as this, we must first determine what articles of consumption we are to call luxuries.

Are we to call those articles luxuries which we are accustomed to consume, but which without any nutritive deprivation, we can forego? If this definition be accepted as the correct one, many articles which at the present day are enumerated—conventionally at least—under the title *luxuries*, would be withdrawn from that category.

Let us for instance take the substance *tea*. Few people will deny that only to a very limited extent, if any, is tea useful as a nutritive agent. The nervous action of tea is very great, and we doubt not that in the greater number of cases it does more harm than good. It is in some cases useful as an astringent. But this is merely from a medical point of view. Let it then be kept under the title of articles called luxuries. Many other substances we can place in the same category; but there are certain others which, although to ordinary ideas they may appear luxuries, are in reality nothing of the kind—that is to say, if we accept as a definition that given above. It may be necessary to remark at the commencement that in speaking of luxuries we shall interpret this word as meaning luxuries in *food* alone.

The question then arises, shall we or shall we not consider sugar as a luxury? If we accept our previous definition, it is not so; sugar helps more than most other substances of a similar character, to build up man's physical constitution, and the more

sugar we consume the more flesh-builder we absorb into our bodies. This then we can scarcely call a luxury, it is an article of food which in its entirety builds up to a very great degree the power-strength of man.

If, for instance, we refer to the substance we have already spoken of, tea—we find that it possesses two properties, that of a narcotic, that of an irritant, thus showing very strongly that it acts upon the human nerves, not assisting to build up the human frame.

Of the other substances which might be placed in the same category as that of tea the same observations may be made; we see from this that there are many substances which, serving only as enjoyments, contribute nothing to pure human welfare. These are the substances upon which taxes should be laid; if we tax sugar we tax a certain amount of strength which can in the ordinary acceptation of life be applied by the individual to the welfare of his brethren. And this idea is not a suppositious one, it can be reasoned carefully out. We can determine the amount of nourishment given by a certain amount of sugar and we can calculate that into a mechanical equivalent of work.

We have thus attained one very determinable point and that is, that a luxury is that which (and we are here considering it merely as an article of food) we can without depriving ourselves of a decided amount of nutriment refrain from regularly using.

It is a very natural thing that Society after Society, Corporation after Corporation, should send deputations to the Exchequer pleading for the diminution of taxation upon this and that, but amongst all the other substances upon which a diminution is demanded that of foods is the most important. "Man shall not live by bread alone," has long been acknowledged in its simplest meaning, but many of the almost necessary concomitants of bread have been so tied down by Government taxes that it has been hard for the poor, or indeed even those in lower middle life to obtain them.

It might be difficult to abolish the malt tax-without abolishing many other taxes, still it is a tax which thinking men, considering not only their own benefits but the benefits of their country would be rather slow to abolish. The abolition of the malt-tax really

means an increase of drunkenness, as by the diminution of the malt-tax the consumption of beer would be considerably greater than it is at present, and a cheaper rate of beer purchase would mean a greater rate of beer consumption.

In the *Saturday Review* of March 14th, 1874, we find the following article :—

SUGAR.

"It is not to be regretted that successive deputations should prefer urgent claims for relief which are necessarily competitive and incompatible. The abolition of the Malt-tax would absorb more than the entire surplus; and, as Sir Stafford Northcote justly remarked, the removal of duties on beer would, by discouraging the consumption of spirits, entail a loss on the revenue beyond the total produce of the tax. The Malt-tax is, indeed, one of the most anomalous and excessive burdens both on consumers and on an important class of producers; but it has the paradoxical property of sustaining itself by its own weight, inasmuch as the removal of so heavy a burden would utterly derange the fiscal equilibrium. The country brewers who lately urged Sir Stafford Northcote to remove the License duty on their trade unanimously disapproved of the repeal of the Malt-tax, or of its conversion into a duty on beer. They fully explained the inconvenience to which they are subjected by the necessary supervision of the Inland Revenue officers, and perhaps they may either now or at some future time succeed in obtaining relief. The still more recent deputation which asked for the repeal of taxes on food injured its own cause by the extravagant demands of some of its members; but it may interest the promoters of the agitation against the Income-tax to be informed of a simultaneous demand for the addition of thirty or forty millions to the present direct taxes. Some years have passed since Mr. Disraeli encouraged the farmers to hope for the repeal or large reduction of the Malt-tax. In one of his late speeches he thoughtlessly announced his disapproval of Mr. Gladstone's scheme of effecting a more practicable improvement. The sugar duty since last year's reduction produces less than two millions of revenue, while it interferes with a complicated system of trade and manufacture. Mr. Lowe's enthusiastic description of sugar as the luxury of childhood and the solace of age was just as well as poetical. If the remaining duty were removed, the article would be cheapened by more than the whole amount of the tax, and the production of the finer qualities of sugar would no longer be artificially restricted. Mr. Disraeli's opinion that the subjects of taxation ought not to be further reduced in number has been formerly held by economists of high authority. Sir George Lewis adopted Arthur Young's recommendation that indirect taxes should be distributed over the largest possible number of commodities, but experience has justified Mr. Gladstone's preference of an

opposite fiscal policy. It is desirable not to interfere unnecessarily with any branch of industry, and the indirect operation of Customs and Excise duties is reduced to the lowest point when the revenue is derived from the smallest number of taxes on consumption. If Mr. Disraeli should be persuaded by the Chancellor of the Exchequer to repeal the sugar duty he might defend his inconsistency by the example of Mr. Lowe, who declared that he would never again meddle with the duty only two years before he reduced by fifty per cent."

This article speaks for itself. We must in the long run have a discontinuance of a tax upon all articles of food which are not included under the definition we have already given under the title of luxury, and until the time comes when we can say that every man in England can sit down nothing doubting to a free breakfast, dinner, and supper table, we are still as much under the tyrany of a Conservative Government—whether that Government be Whig or Tory—as if we were paying double for every article consumed.

Sooner or later, a definition of a "luxury" must be made. We must be able to determine between what is a pure necessary and what is a mere article of enjoyment, and until our Government does this we see very little hope of escaping from those trammels which we are accustomed to call—referring ourselves as mere elements of a jurisdiction—Taxes.

NOTES ON THE HISTORY OF THE SUGAR INDUSTRY OF THE HAWAIIAN ISLANDS.

By Thomas G. Thrum.

Part II.

Sugar, its culture and manufacture, received considerable care and attention from the Royal Hawaiian Agricultural Society, and, doubtless, as much the object of its being brought into existence, as anything else, was, to devise ways and means to promote this industry, as the published papers of the Society will show. That it has done so is plainly to be seen, for immediately following is noted an improvement in cultivation, grinding, boiling, draining, packing, &c., to say nothing of the increased interest taken in it

and the impetus it received thereby from many who had been giving their attention to the whaling interests.

In a paper read before the Society, in January, 1852, by the late L. L. Tobert, he stated that "cane grew without culture, almost everywhere on these islands, as high as 3000 feet. At 1700 feet above the sea it ceases to blossom and continues to grow on, from year to year, for four, five or six years. How long it will grow on the same spot without exhausting the soil would be hard to tell, as he knew of a field, that according to the tradition connected therewith, must have been one hundred years old, and bid fair to produce equally good canes as many years hence. In some soils it may degenerate and die out, while in others it improves by long standing."

During the season of 1851, the first centrifugal drying machine was put in operation at the East Mani plantation. Previously all sugars were dried by the old and tedious process of draining from boxes or barrels, through holes bored to allow the molasses to drain off, leaving it but imperfectly or unevenly dried after all. The centrifugal gave such universal satisfaction, for the improved grades of sugar and the saving of time, that it made a thorough revolution in our sugar industry, for every planter, large and small, changed as fast as their orders could be filled.

The sugar interest suffered severely this year from an unprecedented drought, and was further checked by low prices on the Pacific coast and the establishment of duties. These combined causes resulted in a great falling off in our product, as we find but 21,030 lbs. exported for 1851, the smallest amount since the first year of its exportation, and the tables up to 1855 show an unsteady yield, partly from the above causes and the inefficiency of labour, but after which the total yearly product has shown a steady gain. (For Table of Exports, see November No., 1873.)

Scarcity of labour was seriously felt on nearly all the plantations, but more especially on those of Kanai and Mani, and an effort was made to meet the difficulty by the importation of coolie labour, from China, to work under contract for five years. This for a time gave relief, but did not come up to expectations, for when working with the natives there was continued jealousies,

and when their time was out they preferred to enter the trading or domestic service, to renewing a plantation contract. Labour was a vexed question in 1851, and it has continued to be so ever since.

Our planters ever on the watch for improvement, turned their attention, about 1857 or 1858, to steam as the motive power in sugar making, when the Haiku plantation was established with steam for grinding, boiling, and finishing. Another stride for improvement was in the introduction of vacuum pans for finishing, the first of which was put in operation at the Kaupakuea plantation, in 1860, and the year following one was set up at Lahaina. The mode of sugar boiling, on all the plantations, was, with these exceptions, by the open train, and while our large planters were seeking to improve their works by the addition of steam strike pans, vacuum, or wetzel pans, the number of small planters was increased by the advent of the sorghum pan, which allowed many to start operations on account of the small amount of capital required for commencement.

The number of plantations in operation at this time (1860) were twenty-two, of which nine used steam as the motive power in grinding, twelve were driven by water, and one by animal power.

About this same time an effort was made by a joint-stock company towards the establishment of a sugar refinery in Honolulu, which commenced operations the following year, but after a struggle of six years or so it closed its doors, never having done more than manufacture sugar from the molasses from the plantations and drain the pockets of its stockholders.

During the next four or five years plans were being carried out for the establishment of several plantations on the most liberal scale yet undertaken, with machinery of the latest and most improved kinds, some of which were by joint-stock companies, and some by individuals.

In the latter part of 1866, the late Dr. G. P. Judd undertook the task of gathering together all the information possible relating to the different plantations, and which was offered to the public in the accompanying tabular form. It is not acknowledged to be wholly correct, and those who might assist towards rendering it perfect for some reason or other decline so to do :—

Name of Plantations.	Power.	Acres of Land.	Acres of Cane.	Crop in Tons.	Value of Property.	Em-ployees.	M'nthly Expnses
Kauai.							
Koloa	Water		..	..		..	
Lihue*	Water / Steam	3,200	175	350	50,000	125	1500
Princeville	Steam	17,000	1,200	1,200	150,000	350	6000
Waipaa*	Water / Steam	170	60	20	16,000	40	800
Oahu.							
Halawa	Steam	11,000	100	200	50,000	50	500
Waialua	Water	200	60	70	20,000	25	400
Knaloa	Steam	3,300	300	200	80,000	100	1000
Kaalaea*	Water / Steam	2,100	250	300	70,000	80	1000
Heeia & Nuuann†	Water		..	..			
Kahaluu	Water		30	45		20	200
Kaneohe §			..	..			
Nuuanu	Water	640	30	30	5,000	16	100
Refinery ‡	Steam		..	1,000	40,000	15	1000
Mani.							
Pioneer†	Steam	700	126	500	45,000	80	1000
Lahaima Co.†....	Steam	12	60	500	40,000	110	1800
Waikapu†	Steam		600	600	65,000	75	1000
Hawaiian Mill †	Water / Steam	420	120	300	50,000	45	800
Wailuku †	Water / Steam	1,800	500	800	120,000	170	4000
Haiku	Steam	9,400	575	500	120,000	145	2400
Hobron's.....	Steam		800	300	75,000	100	1000
East Mani	Steam	2,000	500	300	40,000	90	2000
Hana			..	..			
Bal and Adams ..	Water	100	150	300	40,000	30	1000
Lowers	Water / Steam	15,000	850	1,200	200,000	300	5000
Makee	Steam	17,000	800	800	150,000	200	4000
Hawaii.							
Amanulu.....	Water	3,600	375	250	20,000	110	1500
Kaiwiki	Water	6,900	620	500	100,000	200	2000
Pankaa	Water	7,000	150	150	40,000	115	1500
Onomea*.....	Water / Steam	3,000	500	500	100,000	196	1900
Kaupakuea* ..	Water / Steam	1,800	400	400	100,000	175	1500
Kohala	Steam	4,300	650	700	100,000	175	2500
Wights'	Water		..	..			
Honoipu	Animal		60	..			
Waiohinu	Animal / Steam	100	50	50	12,000	20	500
Kona, Hart's	Animal	1,500	75	50	20,000	15	350
Anhankea§			..	..			
Total.....		112,242	10.066	12,115	1,918,000	3172	48,317

* Steam for evaporation wholly or in part.
† Purchase Cane, or Manufacture on Shares.
§ Not in operation.
‡ Use 5,000 barrels of Molasses per annum.

THE MORAL INFLUENCE OF SUGAR.

There is perhaps no article of the present day to which the nations of the earth have taken so kindly as to sugar. With the exception of a few Esquimaux Indians who prefer carbon in the shape of blubber to its more generally palatable form from the juice of the cane, there is scarcely a race of men which does not receive with the utmost satisfaction this charming sweetener of our *cuisine*. This love of sweets is not confined to mankind by any means, but may be said to be a univeral "hankering" after the delights of the palate common to all animated creation, and perhaps kindly implanted in their natures to direct them to the best and most effectual means whereby they may "laugh and grow fat."

That sugar is thus one of the great moving powers of the world no one can for a moment deny who looks at the subject carefully. Let alone the enormous force of heat supplied by it to the animated creation, and which may be resolved into figures by the dynamical theory, its moral influence is pre-eminent amongst the world's supplies. Who can say what influence sugar has had in stimulating the intellect of ants to acquire it, and so raised this tribe, so highly important in the insect economy of the globe, to its present state of astonishing development. We do not know but that some day a "murrain among their cattle"—the *aphidae*—may direct their amazing energy and ordered intelligence into some other channel, and some future naturalist find them nigger-driving on their sugar plantations, forcing black dung-beetles to manure the land and plant some improved sugar-beet in the fertile soil. To what efforts will not necessity and a longing appetite drive the laziest. Sir Wasp, the small-waisted gentleman-robber, who knocks about all day in the daintiest uniform, as if formed alone for love and war, will risk his gay life with the utmost readiness for a forceps full of sugar from some busy hive of his enemies, or a suck of deadly-sweet water half-filled with his slaughtered friends. The same

with flies, the jam pot, the syrup dish, the sugar basin teem with countless legs and active mandibles, like a sugar cask before a grocer's door, with the legs of street Arabs sticking from the top as the owner's heads seek for *sugar* below.

Who has not heard of the bears robbing the bee-hives of their precious contents despite the vigorously expressed dissatisfaction of the owners, happy if a sweet piece be the exchange for a thousand poisoned stilettos. Perhaps, bears may get beyond this stage, they have plenty of nervous force to waste just now and don't much mind having their eyes closed up so that they have their titbit; but bears are by no means stupid animals and may be capable of improvement, so some fine day we may hear of one robbing a workman of his fustian jacket to smoke out the cottage-hive.

We are led to these considerations from the wonderful stimulus that has been given to human thought and energy by the desire, and indeed we may almost say passion, of mankind for the sweets of the table. So much is this understood that the words "sugar" and "sweet" have become almost synonymous with agreeable and pleasant, and to enjoy the "sweets of life" to perfection is equivalent to having the run of a moral sugar cask.

The first western wanderers found the mighty cane of the Indies to be pleasant to the eye and good for food, they found that a mightier industry than that of the humble bee had stored up her sweets for the winters of far off climes, the cells only requiring to be a little more dexterously robbed. So "Afric's sunny fountains" were deprived of their dark-limbed frequenters that they might toil beneath a sun in which they had hitherto basked. Nigger potentates set in motion their dusky hordes to secure prisoners that they might exchange for rum and calico; and sugar thus dropped a moral bomb-shell on the heart of a great continent, that stirred it to its extremities and made many a hideous ghastly cicatrice on its rude, uncultivated breast. Are we not like the flies in the sugar-basin treading one another down in our fierce struggle for the sweets that so soon fall upon us; like the wasps in the sweetly intoxicating liquor that we must drink though we die?

So the blacks are trodden down on many a fair island, until the smell of the negroes' feet on the muscovado rises up suddenly and shocks the olfactory nerves of Exeter Hall, causing a sudden convulsion that throws the African once more on his back in his beloved sun, and there he lies and laughs at the restless race that braves a sun it hates, in its wild endeavours to reach those sweets of life the darky can gather to the full by stretching out his hands.

But Sugar is still King and the infatuated world shouts for its lord, and bearers must be had to lift his palanquin and carry him forward, to smile blandly upon his infatuated worshippers. So another race from another clime, with almond eyes and strange tongue, or supple, dark brown velvet skins, are enticed to visit his domain and become his subject vassals. He is changing the nations of the earth, he is mixing mankind in the pot of the Indies, he is distilling a spirit of unrest from the fullness of the tropics.

When Napoleon stalked over Europe and England swept the seas King Sugar almost shook the conqueror's throne, and set him coquetting with Prince Beet, the younger son, who has now a realm of his own. This younger son too has grown and strengthened with marvellous rapidity, and for all we know may not be at all the last of the race. It is so recently that he has arrived at maturity, and taken an interest in politics, making his voice heard with effect in the councils of the land of his birth, that we in this country can scarcely quite comprehend how the weakling so carefully fostered at the beginning of the century is now a power in Europe threatening to supersede his antiquated papa from the enervating tropics. And what a tropic realm he owns, this king of sweets, and how he still moves the nations like puppets in a show. Shall he do his work of amalgamation and die, this mighty King, lingering out his latter days in some Polynesian isle, like Napoleon in St. Helena, dreaming of the days of his power when he humbled Africans and Moguls together round the tangled breaks of Guiana; robbed the Australasian Islands to couple their graceful inhabitants with the pot bellied remnant of Queensland's blacks; mingled slight Bengalese and sturdy Chinamen with the

bold and graceful but indolent Kaffir; and as the moving instrument of it all, scattered broadcast a hardy race of working and warrior British ants around the torrid zone.

A King indeed is sugar, and he has built himself a noble washhouse by the Clyde, whence he can issue no longer travel-stained, but bright and beautiful, to charm the hearts of his numberless subjects, and stimulate the people into shouting for a "free breakfast table," where he can sit enthroned on silver or crystal, as free as he is welcome. How his subjects strive for his favours and intrigue for his smiles! Your boy is a paragon of virtue, madam, and would not purloin the biggest orange that was ever shipped from Seville, but don't leave the sugar basin out too-long, nor forget that sugar's authority, like that of Rome, is often both temporal and spiritual. Think how many of the old, the poor, and the helpless are made happy, when King Sugar deigns to look in upon their tea, and what strenuous efforts are made by brains almost exhausted as well as those incipient intellects of youth, to gain favour with the monarch.

The moral influence of sugar is almost incalculable, when considered even in its domestic relations, as the sweetener of the cup that cheers, which might otherwise cause a nervous irritation among our fellow countrymen and women, only too readily susceptible under advancing civilization. Where would be the amenities of the dinner table without its sweets; as well have a sitting room with the bare plaster. Perhaps you, sir, are above such weaknesses, you care nothing for tea, you like beef and beer and despise tapioca, nor love rhubarb well-sweetened in the spring. Very good! but how about your particular vanity, the *two* bits of sugar in your rum punch, the nightcap of mulled porter touched by the mighty finger of the monarch cane!

It would be interesting to trace the track of the king, through the countless lanes and numberless nooks of an ever-complicating civilization, to examine his influence amid the thousand industries of the land, from where, like an elephant, he rends down the trees of the forest, that they may form stately ships for his royal journeys, to where he stimulates the artist's brain to create new

forms of elegance in which he may recline. The mines are robbed of their iron for him, the mechanic's workshop resounds with music in his honour, endless machinery is evolved from sleepless brains that it may perform its sleepless work and spread the monarch's favours broadcast over the land. Year after year, he becomes more familiar, and less of the stiff old-fashioned king, and he has now become almost a President of a Republic, and, at any rate, is a well-beloved and universally courted King of the English.

It is hard to say where the moral influence of sugar begins and ends, or how widely it extends. We have seen how it steps boldly into the council chambers of the nations, and sweetly insinuates itself into the humble cottage of the widow, how it shuffles the people of the earth like a pack of cards, builds great cities, and owns countless ships. We are all of us its secret police, and its authority is unquestionable and, as yet, unquestioned. If we could estimate the brain power exercised in its cultivation, preparation and dissemination, the total would compare with that of almost any other product of mother earth, and now that the dark blot of slavery has been removed from its character, few monarchs exercise, on the whole, a more beneficent influence than the widely respected and universally beloved old King Sugar.

THE EDIBLE STARCHES OF COMMERCE, THEIR PRODUCTION AND CONSUMPTION.

By P. L. Simmonds.

(Continued from page 148.)

Yellow pumpkin starch.
Pine starch, and pine farina.
Fecula of Itua.
Maizena—Indian corn fecula.
Meal and tapioca of seeds of gergelim (*Sesame*).
Fecula and tapioca di forno.

Jacatupé starch.
Mango starch.
Potato starch.
Bread-fruit starch.
Carnauba starch from the trunk of *Corpernicia cernifera*.
Shushu or xuxu starch (from a bulb).
Fecula of bananas.
Meal of yam (*Dioscorea sp.*)
Arrowroot fecula (*Maranta*).
Starch of bitter potato.
Starch of Brazil potato.
Meal of Demerara potato.
Fecula of Maira potato.
Water farina of manioc.
Dry farina of manioc.
Beiju of manioc (dried slices).
Flour of manioc gratings.
Puba manioc.
Dry meal of white manioc.
Dry meal of yellow manioc.
Dry meal of white manioc, sold at three milreis the alquiere.
Coarse manioc meal.
Starch of manioc.
Tapioca of manioc.
Carima of manioc in small balls.
Dried meal of Macacheira or Aipim (*Manihot Aipi*), sells at two and a half milreis the alquiere.
Cairima of malacheira in small balls.

Feculas from other roots and bulbs than the manioc are rarely manufactured. The *Maranta arundinacea* is grown in Para; there are two varieties, one with a large long root, which produces the most fecula, the other, named "ounce's paw," from the resemblance it bears to the forefoot of that animal.

The arrowroot, after being subjected to the action of running water, is sometimes buried in the mud until it ferments and becomes a plastic mass, to which they give the name *puba*, as they

do in like manner to the manioc, when it undergoes a similar process.

Jacatupé starch is extracted from the bulbous root of a climber whose leaf is poisonous. The starch is used in soups, puddings, gruels, and other food preparations, and is said to possess important medicinal qualities, in dysentery, nephritic and other diseases.

The manioc or cassava is, however, the plant chiefly cultivated for food purposes in Brazil. No species of plants have been more changed in scientific nomenclature by botanists than these, for they have been classed as *Jatrophas*, *Janiphas*, *Manihots*, *Curcas*, etc. I will adopt the names given by Phol to the two principal species (most of the others seem to be but mere varieties), the bitter or poisonous species, *Manihot utilissima*, and the sweet species, *M. Aipi*.

The manioc would seem to be a native of Brazil; it has been introduced into India, and is grown about Calcutta, Madras, the Straits Settlements, and other quarters. It flourishes better on the borders of the sea and on islands than in the interior of the continent. On the coast of Coromandel the roots are more fibrous, and therefore inferior to those raised in Malabar. It is extensively grown in Guiana, the West Indies, and various parts of Africa.

The tubers of the bitter cassava attain a length of three feet. They can be converted into bread or cakes. The volatile poison of the milky sap is destroyed by pressing the grated root in the first instance, the remaining acridity being expelled by the heating process. The starch, heated while in a moist state, furnishes the tapioca of commerce. Cassava is abundantly cultivated in Brazil and Venezuela — especially at Caraccas, where the singularly uniform temperature throughout the year is only 60° to 70° Faht. It is a very exhausting crop, and stands in need of rich soil and manuring. The propagation is effected by cuttings from the ligneous part of the stem.

The soil destined for manioc must not be wet. In warm countries the tubers are available in about eight months, though they continue to grow afterwards. The growth of the plant upwards is checked by breaking off the buds. The bitter is the

more productive of the two species. The yellowish tubers attain sometimes a weight of 30 lbs. They do not become soft by boiling, like the Aipi or sweet mâñioc.

The sweet species, though a native of tropical South America, extends as far south as the Parana River. The root is reddish and harmless, and can be used, unlike the bitter species, without any further preparation than boiling as a culinary esculent, irrespective of its starch being also available for tapioca.

From the roots of the two species many food products are obtained, among others, coarse cakes made by rasping and pressing the root, which are cooked on a hot plate. The fecula, heated on hot iron plates, becomes partially cooked, and agglomerated in small, hard, irregular lumps, and in this form is known as tapioca. This substance, partially soluble in water, forms a nourishing food, much appreciated in Europe.

Farina of manioc in its crude form is often seen at Brazilian tables, but is more frequently mixed with water and baked in thin cakes, in this state forming the bread of the poorer classes. It thus forms a nourishing and cheap food; and it is to be regretted that in Europe the vendors should palm off potato starch and other similar substances for the more delicate and agreeable cassava and tapioca.

Manioc meal is produced on an extensive scale in the province of Santa Catharina, where they employ improved machines for preparing it, especially in the settlements. These producers supply the markets of the capital and of the other provinces. The foreign export of manioc meal in 1845 was 145,722 alquieres. Manioc is the staple article of food for the whole population. There are more than 14,000 manufactories, and the total production is calculated at upwards of 500,000 alquieres. In abundant years the meal and fecula fall as low as 1 or 2 milreis the alquiere, but in years of scarcity often rise to above 8 milreis. The foreign export was for some time checked by a tax of 2 milreis imposed on each sack exported, but this tax was abolished in 1865.

There are two modes of preparing the root—the wet and the dry process. In the first the grated root is put into water for four or six days, and afterwards kneaded with water, and pressed to

extract the juice. The fecula which remains is sifted and baked in earth ovens, some fresh manioc paste, which has fermented being always added. There are no less than fourteen varieties of the manioc distinguished in the province of Amazonas, some of which mature in six, and others in twelve months.

The dry process is carried on as follows: The manioc is rasped by hand, water added, and then put to the press; afterwards, dried, sifted, and subsequently baked. In making the starch the deposit in the water is left for some time to allow the starch to settle down; it is washed three times, dried in the sun, and is then fit for sale.

The carima, or fine, creamy starch, is prepared by softening the puba manioc in water, after which it is strained and pressed in a sieve, and made into little balls, in which shape it comes to market, although sometimes reduced to farina. It is used in gruels and other food preparations, according to the custom of each locality.

The exports of tapioca from Brazil were 200,725 bushels in 1868, and as high as 332,823 bushels in 1866. In 1871 the exports were about seven million litres, valued at £26,050. The value of the imports of farinaceous substances from Brazil (nearly all tapioca) have been as follows in the last nine years:—

1863	£4,193
1864	5,413
1865	6,404
1866	8,024
1867	13,812
1868	15,188
1869	8,974
1870	12,960
1871	14,992

Twenty years since about 11,000 cwt. of tapioca used to be imported annually from Brazil; now we only receive about half that quantity.

At Santiago, one of the Cape Verdes, the crude farina of manioc costs about 1s. 6d. the decalitre, and when prepared fetches as much as 10d. the pound. One estate, the Praia Rei, on the island of St. Thomas, West Coast of Africa, produces about 150,000 litres of farina of manioc. In Angola, 150,000 lbs. are manufactured

annually. At Mozambique the Portuguese also prepare a good deal, which is sold for export at 2½ to 3½ francs the decalitre (17½ pints); dried slices of the root are sold in great quantity in the markets at 5d. to 5½d. the decalitre.

The common mess of the Balonda Africans is porridge made of the manioc. The meal is stirred into boiling water; as much as can be moistened is put in, one man holding the vessel and the other stirring the porridge with all his might. It is very unsavoury, and no matter how much one may eat, two hours after he is as hungry as ever. When made thin it is like starch made from diseased potatoes.

Eastern Starches.

The water lilies are much used by the Chinese for food. The seeds of *Netumbium speciosum* provide an excellent meal, used like gruel, and the sliced roots furnish a species of arrowroot. The root of *Nymphœa alba*, in Sweden, and of *Nymphœa lotus*, *edulis* and *rubra*, are used for food in Egypt and the East. The starch from the roots of *Sagitaria sagitifolia* is employed by the Chinese, and from the *Alisma Plantago* by the Kalmucks.

At the Paris Exhibition, in 1867, arrowroots were shown in the Indian department from Sarun, from Palhully, from Dacca, from Denra Doon, North Malabar, from Penang, and Singapore. Although not so stated, I presume most of these would be from *Maranta* and some few from *Curcuma* and the Palms.

The *Maranta arundinacœa*, a native of America, was introduced into India about 1840, by Mr. Elphinstone, and is now cultivated in several of the provinces, especially in the Presidency of Madras. It takes twelve or fifteen months to attain its full development. About a year, with good irrigation, brings the plant to maturity in the East, and the roots then contain the maximum of fecula. Thus after twelve months' culture they will afford 16 per cent., and subsequent yields were found on careful investigation by a good botanist (M. Lepine, of Pondicherry,) to be —

Months.	Per cent.	Months.	Per cent.
14	15	17	11
15	14	19	10
16	12		

The fecula is obtained from the underground shoots, which are white, fleshy, about nine inches long by one and a half to two inches in diameter. They contain about twenty per cent of fecula, but by the rude processes of rasping and washing not more than twelve per cent. on the average is obtained. Arrowroot is in extensive use in India, and some is also shipped to Europe.

The root of *Curcuma rubescens* yield a starch like arrowroot. In Travancore it forms a large part of the diet of the inhabitants, but has never been tried much in Bengal.

C. angustifolia yields an arrowroot in Tikor, Benares, and *C. leucorrhiza* in Berar. Specimens of these may be seen in the India Museum.

The wild ginger plant, which furnishes starch, grows everywhere in the district of Chittagong; it is very difficult to eradicate from land, as the smallest root, or piece of a root, that has an eye, will spring up again. The plant dies off in December. A rough experiment was made with this root by the Civil Assistant-Surgeon of Chittagong, Dr. W. B. Beatson, and the yield was estimated at an ounce of starch from one pound of the root. The experiment, however, was not precise enough to be satisfactory, and he was inclined to think that the yield would be much larger, for the microscope shows the root to be loaded with starch granules. The supply of the root being inexhaustible, any quantity of starch might be extracted from it yearly and become a valuable article of commerce.

There would be no expense for cultivation, and, allowing for the cost of digging the root, and manufacturing the starch, by bruising and macerating the root in water, and drying the deposit, the product would be cheaper than Arracan rice, which is largely exported to Europe to be used, not in food, but in starch manufacture for laundry purposes, stiffening fabrics, etc.

It is not easy to decide whether the wild arrowroot plant found in Cuttack is identical with the cultivated arrowroot. A cup of arrowroot made of the one is not distinguishable from one made of the other—except, perhaps, by a slightly earthy taste observable in the wild arrowroot, which is easily accounted for by its imperfect preparation. The cultivation and more perfect manufacture of the

garden arrowroot have been comparatively recently introduced into the province, so that it is neither generally grown nor its produce used by the native. It is made from plants of his own growing, by a native Christian of Khundittur, who sells his produce among the European residents of Cuttack, his price being a little under 6d. per lb. This arrowroot is of excellent quality, and the process of manufacture is as simple as can be. The tubers are taken up in the cold season, washed, put into a large wooden mortar, and mashed. The mash is then taken out and well washed in cold water, the water drained off, and set to stand in flat vessels, in which it deposits a large proportion of the starch, which is rewashed in cold water and set to dry in the sun. The wild arrowroot, known in the bazaars as "Palooa," grows abundantly in the jungles of the district. It is collected in the cold season by the Sahars, the tubers pounded and washed, and the sediment dried in the sun. By these people it is eaten and sold for the manufacture of what is called "Abheer" in the Jubbulpore, and, to a less degree, also in the Cuttack district; the wild arrowroot is made into cakes, or boiled with milk, and thus used as an article of food.

Under the name of "Beychundee" a starchy product is prepared by the Gonds and sold in the bazaars of Jubbulpore. It is not an arrowroot, but bears some resemblance to it when pounded. It is obtained from the stem of some wild jungle plant.

In Akyab a kind of arrowroot, called by the natives Rembowah, is prepared from a root called Pemban-oo, obtainable in large quantites, and sold at four rupees the maund. It may probably be Penda-loo (*Batatas edulis*), but is most likely to be Pen-bwa (*Maranta*). Starch is obtained in Travancore, from the round yam (called Chana in Cochin), *Arum Rumphii*, or *Amorphophallus campanulatus*. Imitation sago is made, in Mergui, from *Tacca pinnatifida*.

In Ceylon there was found great difficulty, at first, in inducing the people of the villages to plant the cassava and arrowroot. While only 50 lbs. of tapioca were made by the natives in 1852, 66,000 lbs. were supplied in 1856; so with arrowroot, the production increased from 50 lbs., in 1852, to 6,900 lbs., in 1856; and

now, instead of importing arrowroot, exports are made from Ceylon.

In India a fecula is obtained from the young roots of the Palmyra palm (*Borassus flabelliformis*, Linn.), which serves as food to the natives. This palm is very extended over India, and is one of the most interesting trees for study, from the numerous products obtained from it. At Goa they prepare a farina and fecula from the wild palm. Sago is obtained from *Caryota urens*, in Mysore, and pearl sago, tapioca, and tapioca flour were sent to the Paris and other Exhibitions from Mysore, Singapore, and Penang.

The trunk of the Japan fern palm (*Cycas revoluta*, Thunberg) is rich in sago-like starch.

In a paper which I read before the Society in 1861, "On the Trade and Commerce of the Eastern Archipelago," I gave the following details on the manufacture and commerce of sago.

"Singapore is at present the chief place of manufacture and the principle mart for granulated sago and "sago flour,' as it is termed in commerce, but which is, in fact, the fecula, or ungranulated starch. The granulated fecula, or sago, of a dirty brown colour, used to be exported from the Archipelago in small quantities, but when the trade to Europe was thrown open, in 1814, the Chinese of Malacca began to prepare a superior starch, known in commerce under the name of pearl sago :—

"There are four or five species of palms which yield sago; those most cultivated are, however, the *Sagas Conigii* and the *Sagus lævis*. These palms are found in every part of the Malayan Archipelago and Philipines as far as Mindanao, wherever there is a genial soil for them, and this consists of a marsh or bog, composed of decayed vegetables, near the sea. They are most abundant in the eastern parts of the Malay Archipelago, at the Moluccas and neighbouring islands, with New Guinea and Borneo, and in the Philippines at Mindanao. In all these sago is more or less the bread of the inhabitants. These palms propagate themselves by lateral shoots as well as by seed, and they die after producing fruit.

"The sago tree, when cut down and the top severed from it, is a cylinder about 20 inches in diameter, and from 15 to 20 feet in

height. The contents would, therefore, be nearly 26 bushels, and, allowing one-half for woody fibre, there will remain 13 bushels of starch.

"It may give some idea of the enormous rate of this produce, if it be considered that three trees yield more food-matter than an acre of wheat, and six times more than an acre of potatoes. It is far from being either so palatable or nutritious as it is prolific, and is never preferred, even where it is most abundant, to rice.

"All the raw sago manufactured at Singapore is brought from islands to the eastward, principally from the north-west coast of Borneo and the north-eastern of Sumatra, with its adjacent isles, from Siak to Indragari, but a considerable portion comes from places more than 1,000 miles distant."

This article is very easily prepared for exportation in its raw state. The tree is cut down, then the pith or cellular tissue is taken out and made up into bundles. In this form some 20,000 tons are annually imported at Singapore, where it is prepared by the Chinese, who clear the meal of farina from the fibres of the pith, or cellular tissue, when the flour is either made up for exportation in its natural state, or is granulated into pearl sago.

The imports of sago have steadily increased in England since the abolition of the duty which was formerly levied.

In 1830 the import and consumption of sago in the United Kingdom was only 3,000 cwt.; in 1841 it was 52,000 cwt.; in 1850, 90,000 cwt.; in 1860, 179,825 cwt.; in 1870 the aggregate of sago and tapioca received from Singapore was 344,000 cwt. of the value of £283,541.

In Singapore, tapioca manufacture has been very successful, but the crop is said to entirely exhaust the soil in five years.

From Penang as much as 10,000 cwt. of tapioca and arrowroot is shipped annually to Great Britain and the United States.

In the colony of Labuan the sago traders have largely increased their business, owing to the Sultan of Borneo having removed some of the obstructions to the transit of sago in the neighbouring rivers, and it is not improbable that this island may yet become the centre of the sago manufacture of the Eastern Archipelago.

In 1867 sago was imported into Labuan of the value of £9811; in the following year the trade increased one hundred per cent., the value of the imported sago being £19,841, and the process of manufacture added £8764 more to the value of the sago.

In Celebes all the inhabitants feed upon sago of a very coarse quality, which may be said to grow spontaneously, affording abundance of subsistence to the inhabitants. The sago plantations are situated in the valleys between the mountains, in swampy ground. There are several kinds of sago trees, some of which will not produce any useful fecula or starch for the first sixteen years. It is collected from trees of eight years to thirty-two or thirty-five years of age, after which the tree becomes hollow, and rots away from the top downwards. A sago tree of ten years' growth will be about 27 feet high, and from 5 to 8 feet girth at the bottom, and is continually yielding its crop. When the substance of the edible sago is 3 to 5 inches thick they cut it, and this will be in two or three months, according to the nature of the soil, and the oftener it is cut the faster it grows.

Australian Arrowroot, etc.

Attention has of late years been much directed to the production of arrowroot in several of the Australian colonies, facilities having been afforded by the culture and distribution of the several plants from the excellent botanic gardens of Melbourne, Sydney, and Brisbane.

Canna Achiras (Gillies), native of Mendoza, is one of the few extra-tropical Cannas eligible for arrowroot cultivation.

C. glauca (Lin.), and *C. coccinea* (Roscoe), yield, with some other Cannas, the particular arrowroot called *tous les mois*. *C. flaccida* (Roscoe) of Carolina is probably also available for arrowroot.

C. edulis (Edwards), the Aderia of Peru, is one of the hardiest of the arrowroot plants, for seeds, even if many years old, will germinate, and are commonly called Indian shot.

This species has been extensively introduced into Australia, and, according to Baron Müller, yields an excellent starch at Melbourne, Western Port, Lake Wellington, Ballarat, and other localities, from plants supplied by the Melbourne Botanic Garden.

The Rev. Mr. Hagenauer, of the Gipps Land Aboriginal Mission station, obtained 220 lbs. of arrowroot from one-eighth of an acre of this Canna. The gathering of the roots in Australia is effected about April. The plant can be set in ordinary ploughed land. Captain James Hall, of Hastings, also prepared starch largely from this root. The starch grains, it is well known, are remarkably large.

Maranta nobilis appears to be the species chiefly cultivated for arrowroot in New South Wales. There were seven exhibitors of arrowroot from it, at Paris, in 1867; Mr. E. S. Hill, Mr. D. L. Waugh, Mr. John Higgins, Mr. E. W. Rudder, Mr. W. C. Hetherington, Melville, Mr. G. T. Lodis, Wiley Flat, near Singleton, and Mr. H. Moss, Shoalhaven; the last three received bronze medals for their products.

In 1870 there were 84 acres of land under arrowroot in New South Wales, from which 13,567 cwt. of arrowroot was obtained, being 18,251 cwt. less than was made in the previous year from only 31 acres of land.

From Queensland 26,368 lbs. of arrowroot, valued at £548, were exported in 1869, the first shipment of a few packages having been made in 1860.

Good arrowroot used to be made in Norfolk Island, while it was a convict settlement, but I am not aware whether the production is maintained since the Pitcairn Islanders have been transferred there.

Arrowroot is made from *Zamia angustifolia* in the Bahamas, etc.

Under the local name of Coonti an arrowroot is prepared in Florida from the fecula of *Zamia integrifolia*. A fecula was also formerly prepared in Florida by the Indians from the saw palmetto, *Chamœrops serrulata*.

Arrowroot prepared in Queensland from *Encephalartus* (*Zamia*) *spiralis* was shown in 1872 at the London Exhibition.

At the Paris Exhibition in 1867, starch made from the seed of the bean tree or Moreton bay chestnut (*Castaneo-spermum Australe*), was shown by the New South Wales Commission and Mr. T. Bawden, of Grafton, Clarence River district, which was highly

commended. The seeds are said to be abundant, and the manufacture inexpensive. This large tree is found in abundance in the bushes from the Macleay River south to Cape York to the north. On examination under the microscope of the samples I obtained there, I feel convinced that this starch is not from a leguminous seed at all, but is merely a fraudulent substitution of cassava starch under a new name.

Mr. C. Moore, the colonial botanist, also exhibited it, and received a bronze medal from the Paris jury for this new starch. I should like to have the point cleared up as to there being any *bonâ fide* production of this leguminous starch in the colony.

Starches of the Pacific Islands.

A considerable production and commerce is carried on in various feculas in many of the Pacific Islands. One or two species of *Arums* especially are utilised. *Arum macrorhizon*, Linn., grows wild in Tahiti, and the rhizomes are occasionally eaten, but the *Arum esculentum*, Linn., the *Colocasia esculenta* of Ray, known under the name of *Taro*, is that most largely cultivated and esteemed for its starch, which is an article of food of prime necessity. The natives enumerate no less than thirteen varieties. The rhizomes range in weight from two to four pounds, but there is great variation, some varieties producing very small roots, and others very large. They contain much fecula combined with a bitter principle, which is dissipated by heat. In preparing the starch, care has to be taken not to rub the pulp on the sieve with the hand, or a blistering effect will be produced. The yield of starch is as much as 33 per cent.

Another plant, largely cultivated, is the *Tacca pinnatifida*, Forster, which is indigenous to the sandy shores of the South Sea Islands, and is known in Oceanea, but especially in Tahiti, under the native name of *Pia*. This plant is, however, now widely diffused. It is met with in China and Cochin China, according to Loureiro. It is cultivated in the Moluccas, Arracan, and other parts of India, and at Zanzibar. It is found in large quantities in Cook's Archipelago, the Hervey Islands, at Raiatea, Huahine, Bora-Bora, Maupiti, the Hawaiian Islands, the Samoas, Tonga, the

Feejee Islands, etc. The tubercles have much resemblance to the potato, but unlike that root the fecula is found chiefly in the centre and not towards the exterior. The proportion of starch yielded is 30½ per cent.

There is a large consumption of this starch in Tahiti, especially for children and invalids, and a considerable export of it under the name of arrowroot. The principal part of that which enters into commerce is made in the islands of the adjoining archipelago, Raiatea, Huahine, Bora-Bora, and Maupiti, where it can be purchased for 3d. to 3½d. per lb. In the Hervey Islands it is sold at 2d.; and Tubuai and Raratonga produce it even cheaper. At Tahiti it retails, or did a few years ago, at 4½d. to 5d. per lb.

From it the main supply of the Feejee arrowroot is prepared. The Tacca starch is much valued in medicine, and particularly esteemed in cases of dysentery and diarrhœa. Its characteristics are readily recognised under the microscope. A Tacca occurring on the Sandwich Islands yields a large quantity of the so-called arrowroot exported from there. Other species, including those of *Ataccia (Tacca) integrifolia*, occur in India, Madagascar, Guinea, and Guiana, all deserving tests in reference to their value as starch plants.

Starch is made from several species of yam (*Dioscorea sativa* and *bulbifera*), but it is difficult to abstract, owing to the ligneous character of the roots, which require to be soaked in water for two days before rasping, and the bitter principle has been removed by washing and torrefication.

A few other starches are obtained. The cassava or manioc is never sold or cultivated, although its starch used to form a common aliment mixed with that of the *Tacca*. From the breadfruit (*Artocarpus incisa*) about 17 per cent. of fecula is obtained.

African Arrowroots.

On many parts of the West African coast arrowroot and cassava are grown and prepared. The Canary Islands, Liberia, Lagos, Sierra Leone, and other districts produce it, but not in any quantity for shipment.

The Cape Colony and Natal—especially the latter—have given

much attention to arrowroot production. *Maranta arundinacea* is the species grown. I have not the recent statistics of the acreage under arrowroot in Natal, bnt in 1864, from 226 acres, the quantity obtained was 2,347 cwt. It is chiefly in the counties of Durban, Victoria, and Tugela that the cultivation centres, but the quantity varies considerably, for 61 acres in Tugela yielded 1,220 cwt.; 66 acres in Victoria, 639 cwt.; and 98 acres in Durban, 488 cwt. In 1866, 2,835 cwt. were produced.

The prices ruling in the colonial market in 1867 were 30s. to 40s. per cwt., but it realised 67s. 6d. in some instances. The freight to London was 45s. per ton.

I was a little puzzled for some time at the incidental mention of Madagascar arrowroot in this country as it is scarcely an article of commerce, but I have traced out that 7 cwt., valued at 35s., were sent from the east coast of Madagascar to the Mauritius in 1868, and 552 cwt. 2 qrs. 17 lbs. of starch of other kinds, valued at £286. *Canna indica*, a native of India, has been introduced and naturalised in the Mauritius, and the *Marauta arundinacea* is also grown there, exhibitors of this arrowroot having sent samples to the Paris Exhibition in 1867.

I have thus skimmed over the surface of this wide and interesting field of inquiry, contributing my mite towards the general fund of information which is so useful on commercial topics, and I trust it will lead to some discussion and added information on the character, quality, and uses of the various starches touched upon.—*Pharm. J. and Trans.*

TESTING SUGAR SOLUTIONS BY MEANS OF AREOMETERS AND THE OPTICAL SACCHAROMETER.

By P. Casamajor.

(*Continued from page* 351.)

As this addition of liquid weakens the saccharometric strength of the solution by 5 or 10 per cent., according to the quantity of decolorizer we have added, we must compensate for this by adding 5 or 10 per cent. to the factor which we have written down. The solution after being filtered is finally placed in the tube of the sac-

charometer and the indication of the instrument is multiplied by the factor obtained by adding 5 or 10 per cent. to the factor of the table.

Numerical Example.—Suppose we have a dark solution. After being diluted with water, it is tested by the areometer and thermometer, showing 11°·4 Balling, the temperature being 25½° C. The excess of 25½° over 17½° = 8; multiplied by 0·020, the coefficient of expansion of a solution of 11° Balling, gives 0·16, which added to 11·4 gives 11·56, which comes nearest to 11·6. Supposing we have a Ventzke instrument, we find in the table marked Ventzke, the factor 2·144, which we write down. The solution being dark we add 10 per cent. of clarifying solution, say 3 or 4 per cent. of sulphate of soda and the balance subacetate of lead. As this addition weakens the solution, we compensate for it by adding to the factor 2·144 10 per cent. of its value = 0·214, which gives 2·358. The solution, after being clarified by filtration is placed in the saccharometer, and there shows, say, 22½ per cent. By multiplying 2·358 by 22½, we obtain 53, which is the percentage of pure sugar in the dry substance of the solution.

When speaking of Ventzke's process we have seen that the areometer used indicates specific gravity 1·1, and that by means of a table the operator is able to work with liquors having temperatures different from 17½° C. To correspond to the numbers in this table, the areometer is marked above and below the point 1·1 with numbers corresponding to temperatures above and below 17½° C. Having had one of these instruments to verify, I found Ventzke's process so extremely long and tedious, that I was led to make a table, which is given here. This table is calculated from the formula already given :— $S \times \frac{26{\cdot}048}{P \times D}$

in which, as before, S is the degree of the saccharometer, P the specific gravity, and D the degree Balling, or percentage of impure sugar in the solution. Persons having Ventzke's saccharometer usually have these areometers, which are made in Berlin, and are generally very accurate. It is for the benefit of those having these areometers that this table and the following are given here. They will find that much time and trouble are saved by their use.

Table of factors, corresponding to specific gravities, to be multiplied by the percentage given by the saccharometer.

Specific Gravity.	Factor.	Specific Gravity.	Factor.	Specific Gravity.	Factor.
1·0950	1·054	1·0985	1.017	1·1020	0·983
1·0955	1·048	1·0990	1·012	1·1025	0·977
1·0960	1·042	1·0995	1·006	1·1030	0·972
1·0965	1·037	1·1000	1·000	1·1035	0·967
1·0970	1·032	1·1005	0·995	1·1040	0·963
1·0975	1·027	1·1010	0·991	1·1045	0·958
1·0980	1·022	1·1015	0·987	1·1050	0·954

Corresponding to the specific gravities, are the following coefficients of apparent expansion for correcting temperatures:—

Table of coefficients of expansion for correction of temperature.

Specific Gravity.	Coefficient.	Specific Gravity.	Coefficient.
1·095	0·00024	1·101	0·00027
1·096	0·00025	1·102	0·00027
1·097	0·00025	1·103	0·00028
1·098	0·00025	1·104	0·00028
1·099	0·00026	1·105	0·00029
1·100	0·00026		

Numerical Example.—To illustrate the use of these tables, suppose we have a solution in which the arcometer indicates specific gravity 1·1015, and the thermometer 28° C. In the first place we find that $28° - 17\frac{1}{2}° = 10\frac{1}{2}°$ C.; this number multiplied by 0·00027, coefficient of expansion corresponding to the specific gravity, gives 0·00283, which added to 1·1015 (as $28 > 17\frac{1}{2}$) gives 1·10433, which comes nearest to 1·1045 in our table of factors. The corresponding factor is 0·958, which we write down. If the solution is dark and has to be clarified, suppose we add sulphate of soda and subacetate of lead, so that the whole addition is 10 per cent.

of the liquid to be tested. To compensate this, the factor has to be increased 10 per cent. 0·958 + ·095 = 1·053. If the saccharometer shows 82, the percentage of dry sugar in the substance will be $82 \times 1{\cdot}053 = 86{\cdot}346$.

Dubosco.

Table of factors, corresponding to degrees Balling, to be multiplied by the indication of the saccharometer.

Degree Balling.	Factor.	Degree Balling.	Factor.	Degree Balling.	Factor.	Degree Balling.	Factor.	Degree Balling.	Factor.
5·	3·206	7·	2·271	9·	1·753	11.	1·423	13·	1·194
5·1	3·151	7·1	2·240	9·1	1·734	11·1	1·410	13·1	1·185
5·2	3·097	7·2	2·207	9·2	1·714	11·2	1·397	13·2	1·176
5·3	3·042	7·3	2·176	9·3	1·695	11·3	1·384	13.3	1·166
5·4	2·988	7·4	2·147	9·4	1·676	11·4	1·371	13·4	1·157
5·5	2·933	7·5	2·116	9·5	1·657	11·5	1·358	13·5	1·148
5·6	2·879	7·6	2·088	9·6	1·640	11·6	1·346	13·6	1·139
5·7	2·824	7·7	2·061	9.7	1·622	11·7	1·334	13·7	1·130
5·8	2·770	7·8	2·034	9·8	1·605	11·8	1·323	13·8	1·122
5·9	2·715	7.9	2·007	9·9	1·588	11·9	1·311	13·9	1·113
6·	2·661	8·	1·980	10·	1·571	12·	1·299	14·	1·104
6·1	2·622	8·1	1·955	10·1	1·555	12·1	1·288	14·1	1·096
6·2	2·583	8·2	1.931	10·2	1·540	12·2	1·277	14·2	1·088
6·3	2·544	8·3	1·906	10·3	1·524	12·3	1·266	14·3	1·080
6·4	2·505	8·4	1·882	10·4	1.508	12·4	1·255	14·4	1·072
6·5	2·466	8·5	1·860	10·5	1·493	12·5	1·244	14·5	1·064
6·6	2·427	8·6	1·839	10·6	1·479	12·6	1·234	14·6	1·056

Dubosco.

Table of factors, corresponding to degrees Balling.—continued.

Degree Balling.	Factor.	Degree Balling.	Factor.	Degree Balling.	Factor.	Degree Balling.	Factor.	Degree Balling.	Factor.
6·7	2·388	8·7	1·817	10·7	1·465	12·7	1·224	14·7	1·049
6·8	2·349	8·8	1·796	10·8	1·451	12·8	1·214	14·8	1·043
6·9	2·313	8·9	1·774	10·9	1·437	12·9	1·204	14·9	1·034
								15·0	1·027

Ventzke.

Table of factors, corresponding to degrees Balling, to be multiplied by the indication of the saccharometer.

Degree Balling.	Factor.	Degree Balling.	Factor.	Degree Balling.	Factor.	Degree Balling.	Factor.	Degree Balling.	Factor.
5·	5·107	7·	3·618	9.	2·792	11·	2·267	13·	1·902
5·1	5·013	7·1	3·568	9·1	2·762	11·1	2·246	13·1	1·887
5·2	4·920	7·2	3·519	9·2	2·731	11·2	2·225	13·2	1·873
5·3	4·826	7·3	3·470	9·3	2·700	11·3	2·204	13·3	1·858
5·4	4·733	7·4	3·420	9·4	2·670	11·4	2·184	13·4	1·844
5·5	4·639	7·5	3·371	9·5	2·640	11·5	2·163	13·5	1·829
5·6	4·559	7·6	3·328	9·6	2·612	11·6	2·144	13·6	1·815
5·7	4·479	7·7	3·284	9·7	2·585	11·7	2·125	13·7	1·801
5·8	4·399	7·8	3·240	9·8	2·558	11·8	2·107	13·8	1·787
5·9	4·319	7·9	3·197	9·9	2·530	11·9	2·088	13·9	1·773
6·	4·239	8·	3·154	10·	2·503	12·	2·069	14·	1·759
6·1	4·171	8·1	3·116	10·1	2·478	12·1	2·052	14·1	1·746
6·2	4·103	8·2	3·078	10·2	2·453	12·2	2·034	14·2	1·733

VENTZKE.

Table of factors, corresponding to degrees Balling.—continued.

Degree Balling.	Factor.	Degree Balling.	Factor.	Degree Balling.	Factor.	Degree Balling.	Factor.	Degree Balling.	Factor.
6·3	4·035	8·3	3·039	10·3	2·428	12·3	2·016	14·3	1·721
6·4	3·968	8·4	3·001	10·4	2·403	12·4	2·000	14·4	1·708
6·5	3·900	8·5	2·963	10·5	2·378	12·5	1·982	14·5	1·695
6·6	3·844	8·6	2·929	10·6	2·356	12·6	1·966	14·6	1·683
6·7	3·787	8·7	2·895	10·7	2·334	12·7	1·950	14·7	1·671
6·8	3·730	8·8	2·860	10·8	2·311	12·8	1·934	14·8	1·659
6·9	3·674	8·9	2·826	10·9	2·289	12·9	1·918	14·9	1·648
								15·	1·636

From the *American Chemist.*

PERFECT GAS-HEATING BY COMPLETE COMBUSTION AND UNDER CONSTANT VOLUME OF THE BURNT GASES.

(*Continued from page* 143.)

General Arrangements, on which rest Economic Gas-Heating by Complete Combustion and under Constant Volume.

CHAPTER III.

Description of the New System—Gasogène—Smoke-consuming Apparatus—Hydraulic Regenerator.

XVII.

The new system of heating that I propose, and of which I hope this examination will have shown the enormous economic advantage, finds its explanation in the following heading:—

Economic Gas-Heating by Complete Combustion and under Constant Volume.

As this title suggests, I propose to heat all furnaces whatever

by means of gases produced previously in a special gasogene, by compressed air, and to prevent these gases, after their combustion, from freely expanding, as they do in all furnaces hitherto employed.

The replacing of ordinary heating by heating with gases under compressed air, already often attempted, has so far failed, so far succeeded, within certain limits. However that may be, whoever has studied the question, this last mode of heating gives to the manufacturer who knows how to use it great advantages, but these will be found greatly increased by the application of the improvements I am about to describe.

The most important of these improvements rest on the practical application of principles already established and developed.

We have seen that a great cause of the loss of heat in all the manufacturing furnaces lies in this fact, that they allow the products of combustion to expand freely. By that they allow their caloricities to increase often in considerable proportions, and consequently they lose a distinct quantity of caloric passing from the sensible state to the latent state. More, the molecules of these smokes, in spreading out the one from the other, absorb another less important quantity of heat, which changed into internal molecular action, pass again into the latent state.

These two quantities of heat which, produced by the manufacturer in his furnace, escape him again entirely, form an important total loss that I undertake to check completely by forcing the combustion to take place under constant volume.

It is there really that the great interest of the question rests, and not in the more or less great pressure to which the burnt gases are subjected.

The main object of my invention is then to obtain all the combustions primarily, and prevent as much as possible the expansion of the burnt gases. The calculations of the first portion have sufficiently shown that the chimney was the great plague of industrial heating. It is it that my apparatus is meant to replace.

This new system comprises three principal parts:—

The gas-producing apparatus or *gasogène*.

The apparatus for the combustion of the smoke-consuming gases.

The hydraulic regenerator apparatus.

XVIII.

The *gasogène* that I use is known in principle.

It is by air forced by any bellows and by a steam jet on the ignited fuel. I place it as near as possible to the apparatus of combustion in order to utilize the sensible heat of the gases. In certain cases I retain for myself the possibility of interposing a regulator reservoir between the gasogene and the apparatus of combustion.

XIX.

The smoke-consuming apparatus, taking the form of a blast-pipe, receives the very hot gases coming from the gasogene, and is generally separated from it by a simple valve.

The object that I propose for myself in using this blast-pipe is to bring about a mixture of the air and the gases as intimate as possible before combustion. In order to obtain this, this blast-pipe is so placed that the air, contrary to the usual custom, may surround completely on all sides the gases to be burned.

The air comes then in the shape of a wave all round the jet of gas, but that it may penetrate it more intimately, I place before these waves of air and of gas a metallic gauze pierced with small holes, so that the air and the gases are divided into fluid veins, and not simply into waves, mixing integrally before burning, and, consequently, producing a complete combustion free of smoke. The arrangement of this blast-pipe will be square, rectangular, or circular, according to the furnaces to be heated. The size of air and gas passages will depend on the particular case and the fuel employed.

I lead the air on the gases, acording to a certain angle *a*, which alters according to the particular case and the length of the flame

to be produced. I retain to myself the possibility of heating the air of combustion of the blast-pipe by the radiating heats lost in the heating apparatus.

In the case of tubular boilers, having a metallic fire-box like the furnaces of locomotives or steamer engines, I use in place of the preceding blast-pipe a cast or sheet iron box pierced with holes, through which the air and the gases escape, these last being always surrounded by the first. This mode is arranged vertically or horizontally, as the case may be, square or circular, according as it is to be applied.

XX.

The hydraulic regenerator, receiving the burnt gases at their exit from the heated bulk, produces the following effects:—

1st. The almost entire utilisation of the sensible heat brought by the burnt gases after their action on the heating apparatus, a heat relatively very considerable, and until now only used in producing the costly draught of the chimney, this natural draught being rendered useless by the use of compressed air, which employment constitutes by this fact an economy of more than 25 per cent.

2nd. The regeneration of the latent heat of vaporisation of the water contained in the fuel, and of the water formed by the combustion of its hydrogen, this latent heat being transformed by my apparatus into sensible heat capable of being utilized.

3rd. The regeneration of the heat lost until now by the increase of caloricity of the gases, the combustion under constant volume preventing this heat from passing into the latent state, and keeping it in the sensible state—that is to say utilisable.

4th. The regeneration of the heat employed until now in the internal action of the expansion of the gases, the apparatus not allowing them to expand freely.

5th. The regenerator assists the apparatus of combustion in producing complete smoke-consumption.

6th. In fine, the water of the regenerator being almost always destined for feeding steam boilers, and this water being raised to nearly 100°, the carbonic acid it contains in excess is separated

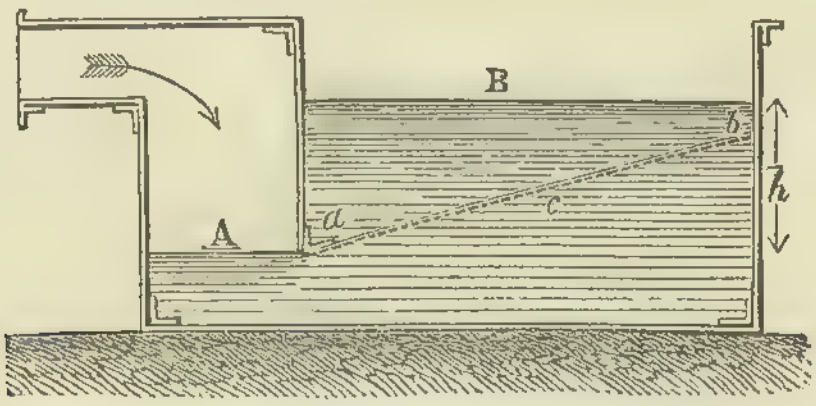
from it, the lime salts, held in solution from this excess of carbonic acid, settle in the regenerator, and the feeding water arrives in the boiler entirely free from encrusting properties.

This result, due to the use of the regenerator, is of the highest importance.

Here is what the regenerator consists of:—

Let us suppose that we send into the capacity to be heated (which will be, for example, the "*carneau*" or the tubes of a steam regenerator) a known weight, of a lighted gaseous mixture, provided with any excess of pressure whatever over the atmospheric pressure, this mixture tends to expand, and its pressure will diminish—that is, what is produced without obstruction in all the industrial furnaces placed by their chimney in free communication with the atmosphere.

In place of that, profiting by the excess of pressure possessed by the mixture on its exit from the blast-pipe, I force it to preserve a constant volume from this blast-pipe as far as my hydraulic apparatus, and for this purpose I direct it on its exit from the heated space into a sheet-iron receiver containing water, and divided into two parts, of sections more or less unequal, according as the case may be. These burnt gases, by virtue of their excess of pressure, cause the surface of the water to lower at *A*; it rises in *B*, and the difference of level *h* will measure very nearly the excess of final pressure of the burnt gases.



The apparatus being arranged in such a manner that this excess of pressure may be able to cause the level to sink in the part *A* a little below the plane of the junction *ab*, it follows that the gases, in virtue of their specific lightness, tend to rise in the part *B*, bubbling slowly across the water found contained there. In order

to facilitate their diffusion through the liquid and render their contact perfect with it, I oblige them to pass by numerous holes pierced in a plate of sheet-iron slightly inclined *c* and fixed at *ab*. If the surfaces and height of the water are well calculated we get this result, that the gases in arriving at the top of the part *B* will be relieved there of their excess of heat and pressure.

We see clearly that in this manner I reach the result of knowing that if I inject a cubic meter per second into the blast-pipe there will come out sensibly in the same time from the regenerator a cubic meter of gases completely burned, consequently that the constancy of their density and of their volume will be obtained, and that the various quantities of heat formerly indicated will be completely regenerated.

Several cases of general application can present themselves, according to the pressures that one may wish to obtain in the heated capacity.

The regenerator apparatus can be applied always, even in the case of metallurgical furnaces where the pressure of the gases might exceed two absolute atmospheres. I will not stop here to describe these wholly special arrangements.

In fine, it is useless to say that in every case the chimney will be destroyed, or better, completely closed by a register.

THIRD PART.

Determination of the Advantages and of the Practical Conditions of Establishment of the New Mode of Heating.

CHAPTER I.

Examination of the Losses still sustained in the Application of the New System—Jet of Steam thrown on the Grate or Gasogène—Effect produced—Calculation of the Air-blast in a given case—Composition of the Gases of Combustion employed.

XXI.

I am about now to reconsider in a few words the various conditions of a good heating apparatus, and the losses actually

incurred in industry, and see in what proportion the system of heating previously described satisfies the one and prevents the second.

We have seen that a good combustion demands :—

1st. That the fuel and the burning agent should be intimately mixed.

This first condition, so important, we have seen was never satisfied in ordinary firing. We have concluded also that heating by gas with the natural draft, which have for their principal type Siemens' mode, could no more reach this necessary end.

In the new system, on the contrary, we see from the first that the mixture be perfect, seeing the use of air currents and of gases under pressure increasing under a certain variable angle, the gas being entirely enveloped by the air of combustion.

2nd. The second condition that the fuel and the burning agent ought to be of the same physical nature is here clearly satisfied.

3rd. The third condition bears that the gases ought to be placed in contact at the necessary temperature for their perfect combination ; this condition will also be satisfied, since the gases arrive very warm at the blast-pipe, and as the air of combustion will be more or less warm, according as the case may be.

4th. It is necessary that the proportions of fuel and of the burning agent be those exactly required by the result of the combustion.

This last condition, impossible to satisfy with a ribbed furnace, very difficult to reach with currents of the natural gas, will be very easy to realise here, since we have entirely at command the distribution of air and gases at will.

Let us see now in what proportion the losses, formerly determined in an ordinary warming apparatus, are prevented.

XXII.

1st.—Loss due to Excess of Air.

This loss entirely disappears here since the fourth condition of good combustion, above described, is satisfied.

2nd.—Loss due to the Chimney Draught.

In this new system the chimney disappears, and the hydraulic

regenerator utilising almost entirely the sensible heat of the burnt gases, this second loss is prevented. We must add that it is replaced by air of much less importance due to the use of the ventilator. I will calculate it afterwards.

3rd.—Loss Due to want of Smoke Consumption.

From the fact that the air and the gases are closely mingled, this cause of loss entirely disappears.

4th.—Loss due to Cinders.

This likewise disappears, the cinders of the gasogene being gathered and afterwards recharged.

5th.—Loss due to Vaporising 48 *Kil. of Water.*

This loss is prevented by the use of the regenerator; the vapour of water produced contained in the burnt gases in bubbling in the water of this apparatus condenses there completely, and its latent heat of vaporisation is thus entirely utilised.

6th.—Loss due to Radiation.

In the ordinary system I have only noted it as a memorandum; here it is, so to say, annulled—in the gasogene by the water of the grate and the circular current of air, in the fireplace or furnace by heating the air of combustion.

I now reach the losses confined to the new system of procedure.

XXIII.

7th.—Loss arising from the Change of the Carbon into Protoxide.

This cause of loss or waste of heat, inherent to all economic gas-heating, we have seen to be equal to 20 per cent. in the Siemens and analogous modes, and I have shown how, in this case, it was impossible to recover any of it whatever.

In using a gasogene with forced air, on the contrary, experience has shown for many years, and again recently in several attempts at the furnaces of Montutaine, that steam could be injected in the gas-producing furnace, to use a portion of the heat in question to decompose this vapour, and thus to enrich the gases of combustion.

In order to decompose a given quantity of steam, we shall have

to spend the necessary heat to disunite the hydrogen from the oxygen. But, on the other hand, the vapour carries in itself a certain quantity of caloric, which is its latent heat of vaporisation, comprising the latent heat and the sensible heat, which total heat varies with the temperature of that vapour, and plays a favourable part in enabling us to subtract it from that necessary for the disunion, and of which it is necessary to take count.

Let us observe at starting that the greater or lesser quantity of vapour injected will be all in our control, and let us inject less or more, we will always be enabled to utilise the bulk of the heat disengaged by the burning charcoal on the grate of the gasogene.

If I call positive heat that produced, negative heat that absorbed, the reaction that we produce on our grate may be summed up in this object of attainder.

Strive to maintain the superiority of the positive heat over the negative heat, in order to retain in the gases of combustion, before their arrival at the blast-pipe, a certain sensible heat.

What follows goes to prove that it will be allowable for us so to arrange our apparatus as only to have as loss of heat, that arising from radiation, and this we could reduce to a minimum, first, by keeping the ashpit perfectly closed, then by utilising a great part of the heat radiating from the grate by a tank of water situated below; which will produce steam that in rising will be decomposed by crossing the burning fuel, and will thus come in aid of the injected steam; in fine, in causing the air of injection to circulate around the coating of the gasogene.

The total heat produced by the change of the carbon into oxide, in place of being completely lost or used in the draught, as in Siemens' process, may here be entirely recovered and will be divided into three:—

1st. That retained by the gases before their arrival at the blast-pipe in the state of sensible heat.

2nd. That employed in the decomposition of the steam.

3rd. That very small quantity distinctly lost by radiation and which may even, by special arrangements, be almost wholly prevented.

The two first will be balanced by us as it seems good, since we are able to vary the quantity of steam injected. At the same time, let us endeavour to fix a figure for this quantity from practical experience.

Experiments to which I have subscribed, have been several times made on this special subject, at the Montataire furnaces. The gasogene used went almost correctly with 100 kil. of fuel consumed per hour, half coke and half coal. The injected steam was very well decomposed. In one of the experiments we sent 62 kil. per hour of it, in another 46 kil. In order to be within wise limits, I will adopt, in practice, the injection of a weight of vapour capable of uniting with the half of the weight of the burnt carbon, or say 33 kil. Let us analyse the phenomenon.

The carbon burnt by the air is transformed into carbonic acid. There are 32 kil. of carbon in this case. These 32 kil. after this reaction pass again into the state of protoxide and thus form 74·67 kil. of carbonic oxide, requiring for this change 185·52 kil. of air.

The 33 kil. remaining attacked by the steam are changed into a mixture of CO and C^2H^4, showing the presence of an excess of carbon, and exactly decompose 33 kil. of steam. The gases resulting from this reaction will be:

51·328 kil. of CO.

14·6668 kil. of C^2H^4.

Let us see what will be the heats produced and absorbed, that I have called positive and negative, in these various reactions:

1st. Change of 32 kil. of carbon into CO^2:

$32 \times 8080 = 258560$ heat units. (positive heat.)

2nd. Change of 21·998 kil. of carbon into CO:

This will be $21{\cdot}998 \times 2473 = 54401$ heat units. (positive heat.)

3rd. Change of 11·001 kil. of carbon into C^2H^4:

About 3623 heat units. (positive heat.)

4th. Left by the steam or brought by it from its total heat of vaporisation, taken at five atmospheres:

This will be $653 \times 33 = 21549$ heat units. (positive heat.)

5th. There would still be the heat brought by the air of the

blast, that we will heat; but this last heat being considered from the radiation, is of little use to consider here.

If I add the positive heats thus arrived at, I find:

258560 + 54401 + 3623 + 21549 = 338133 heat units.

The result of these combustions is a very high temperature, but at the same time, two actions take place which are explained by a total negative heat.

1st. The decomposition of the 33 kil. of absorbed steam:

126362 heat units.

2nd. The 32 kil. of carbon having produced carbonic acid pass again into the state of oxide and absorb by that:

179424 heat units,

which makes a total of negative heats equal to 305786 heat units. Or an excess of the positive equal to 32347 heat units.

This excess will be, for the most part, utilised by keeping in the gases a sensible heat, sufficiently considerable and very useful for their subsequent combustion. A very simple calculation shows that, in this case, the temperature of these gases at their entrance into the blast-pipe will be about 350°, a very suitable one.

We see, besides, that in causing the proportions of the injected steam to vary, we can increase or diminish this temperature, at need and at will. In all I have just said, I have taken the air of injection at 0°, there will never be any if it is so, for I inject on the grate of the gasogene air more or less warm, and consequently I bring a new positive heat, which at the finish will evidently be again found in the sensible heat of the gases on their arrival at the blast-pipe.

To finish this examination which seeks to establish distinctly the loss due to the change from carbon into protoxide, I have to compare the advantage derived from this injection of steam to the loss occasioned by it.

1st. The injection of steam and its decomposition have enriched the gases within a certain limit, and consequently the calorific power of the combustible gases has varied.

2nd. There is the waste of heat by the use of the steam injected.

We will settle these two points:

1st.—Enrichment of the gases by combustion.

In bringing together the various numbers above established, we reach for the composition and the calorific power of the combustible gases the hypothesis of an injection of 33 kil. of steam, per 100 kil. of coal, at the following figures:

		Kil.			Heat-units.
Coming from the steam	C^2H^4 ..	14·6668	×	13063 =	191592·4084
	CO	51·328	×	2403 =	123341·1840
Coming from the air.	CO	74·67	×	2403 =	179432·0100
Tar	C^4H^4 ..	5·	×	11858 =	59290·0000
Coming from the lighting gas ..	H.	0·24	×	34462 =	8270·8000
	C^2H^4 ..	14·16	×	13063 =	184972·0000
	C^4H^4 ..	1·60	×	11858 =	18972·8000
	CO	2·60	×	2403 =	6247·8000
				Total.....	772119·1624

If we do not inject steam we obtain a gas, of which the calorific power will be:

	K		
CO.	151·66667 × 2403	=	364455·00801
Tar		=	59290·00000
Lighting Gas		=	218463·56000
		Total.....	642208·56801

which gives us a gain due to the decomposition of steam equal to:

772119·1624 — 642208·56801 = 129910·59 heat units.

not forgetting besides that we ought to add to these numbers the sum of the heat units representing the sensible heat retained in either case by the gases of combustion on their arrival at the blast-pipe.

2nd.—Waste caused by the use of the injected steam.

We have supposed a consumption of 33 kil. of steam at five atmospheres. The total theoretic heat contained in this steam is equal to:

33 × 653 = 21549 heat units.

But the real loss is much more. In supposing that the fire-place, that has produced it only utilises two-thirds of the heat furnished by the fuel, which would be a large minimum, supposing the new system applied to it, we could carry this loss to:

about 28000 heat units.

We see what a very distinct advantage the injection of steam produces. The last calculation goes to show that the distinct loss due to the change of the carbon into protoxide is very small, not to say *nil*, in this system.

Truly, comparing the heat units produced and saved we see only a part.

The 65 kil. of carbon will have disengaged:

$$65 \times 2473 = 160745 \text{ heat units.}$$

The loss due to the use of steam is, we have just seen, equal to:

28000 or a total of 188745 heat units.

We have seen before that the enrichment of the gases represented 129910·59 heat units, the loss will then be equal to:

$$188745 - 129910{\cdot}59 = 58834{\cdot}41 \text{ heat units.}$$

But let us not forget that this exceeding heat is in great part utilised in the sensible heat of the gases of combustion. We have found, before this, 32347 heat units.

There would have been then a surplus equal to 26487·41 heat units, which is no more lost, for it is, in great part, utilised by the heating of the air which surrounds the gasogene and the vaporising of the water situated under the grate. At the same time, in order to place myself in a hypothesis adverse to my argument, I will allow a distinct loss equal to: 20000 coal units, or

$$\frac{20000}{803779{\cdot}6} = 2{\cdot}5 \text{ per cent.}$$

XXIV.

Loss or waste of heat arising from the use of a bellows:

In order to determine this last point, we must first calculate the quantity of air required in the gasogene and the blast-pipe.

The air required for the blast-pipe will vary according as the gas of combustion will be produced, with or without injection of steam.

In the case of non-injection of steam, we arrive by a very simple calculation, that I will not detail here, by applying the various figures previously determined, at fixing the quantity of air

required at 0° and 760° for burning the gases arriving at the blast-pipe, as equal to:

742·72985 kil.

I have supposed the hydro-sulphuric acid escaped in the combustion.

In the case where we consider the use of the gas products with injection of steam, we find for the weights of the air required for their combustion:

933·94315 kil.

As to the quantity of air to be injected under the grate of the gasogene it will be equal, in the first case, to;

376·8 kil.

And in the second to:

185·52 kil.

If we sum up we find, in the first case:

1119·5 kil.

And in the second:

1119·5 kil.

These two numbers are equal. There springs thence an interesting *theorem* of combustion, that we may thus enunciate.

The air required for the final change into carbonic acid of a given weight of carbon is the same, whatever may be the quantity of steam injected on this lighter carbon to decompose it.

This, otherwise, is very easily explained; for in decomposing steam, we introduce, on the one hand, oxygen; consequently we diminish the air required, but on the other hand, we introduce hydrogen which requires a new quantity of oxygen to burn it, and exactly the same as that already entered into combination.

Then, the final and total quantity of air required is unchangeable.

We see then in conclusion that this vapour blast brings no excess of waste from the injected air, and that the variable quantity of steam will not lead to any disturbance in the course from the ventilator.

The quantity of air required for combustion being decided, we shall easily arrive at the waste caused by the use of the ventilator.

The 1119 kil. of air represent a volume of $861^{m.c.}$ at 0° and

760°. As the medium temperature is 15°, let us take in round numbers 1000 m.c. per hour, or 16·666 m.c. per minute.

If we allow that its pressure ought, at its entrance into the gasogene, to exceed the atmospheric pressure of 0·15 m. of water, and that we attribute to the ventilator a return of 20 per cent., we find that its power ought to equal at the highest 3 horse power, say about a loss of 60 kil. of steam, and consequently scarcely 5 per cent. of the total theoretic power.

If we take for the air a pressure of 0·10°, we obtain a still smaller number. Let us add, if it is a question of a more important consumption of coal, necessitating the use of a piston-blast, this loss will be relatively less.

However that may be, the pressure of the air equal to 0·15m. of water, being a suitable medium, I take 5 per cent. as the loss we are seeking for.

XXV.

Apropos of this, I will say a few words on the use of hot air in these circumstances. *A priori*, it appears that an economic advantage ought always to arise from its use. A very simple calculation will show that in reality we might gain 7 per cent., supposing the air injected at 200°. But this advantage is not so complete as it appears at first sight.

In fact, the heating of the air increases its volume in a distinct proportion, hence this result, that the mixture with the combustible gases is rendered more easy. Each atom of gas requiring to be in contact with a volume of air ten times as large as its own, we ought to be on our guard against increasing the difficulties, already considerable, that are opposed to a perfect mixture.

On the contrary, the heating of the gases is altogether advantageous, in this sense, that if the air is not heated the mixture is facilitated for the contrary reason of that just given, and that further the combustion of the gases is very quick when they are brought into contact with very heavy air at a high temperature.

At the same time we ought not to proscribe the use of hot air, but it only appears to me necessary for obtaining very high temperatures which is not the case in heating a steam generator.

If now we sum up the various losses that we have settled as owing to the new system, we conclude that the six first are so to say wholly ommitted, and we have to consider only the seventh and eighth of which the total is 7·5 per cent., now the ordinary system of heating in a medium case has given us 73 per cent.

We see then what enormous advantage the application of the new mode produces. And at the same time in analysing the previous discussion, we ought to understand that I have spoken of the advantages of my system rather with moderation than otherwise.

We shall aknowledge then readily that there remains to us still a very good margin to allow for small and unknown losses which might show themselves as in establishing all new modes; a proportion sufficiently great to leave us at the same time at the summing up a distinct and great economy.

We shall be all the more convinced of it when we shall have added to this important economy of fuel the various special advantages in the use of this system, and which are enunciated further on.

Before finishing this examination, I wish to say yet a few words touching the practical procedure.

XXVI.

Experiments have been made at the furnaces of Montataire, I have already spoken of them, some have had for end the use of lighting gas. Now they have proved peremptorily that we might reduce a puddling furnace to a consumption of 43 cubic metres of this gas at 0° per 100 kil. of bar iron. Say a weight of this gas is equal to:

$$43 \times 0{\cdot}558 \times 1{\cdot}293 = \overset{\text{Kilgs.}}{31{\cdot}04342};$$

of which the calorific power is equal to 339,056 heat units.

In comparing this loss with that made on an average at the same furnace heated by an ordinary grate with open fire, we find that this use of lighting gas economises heat equal to 45 per cent.

I say economy of heat, not of money, for the combustible lighting gas is dearer than coal of the same calorific power.

But that no way weakens the conclusion that we ought to draw

from these experiments as the immense advantage derived from the use of the gases; this economy of heat is almost entirely due to the more complete combustion, to the non-excess of air, and to the abolition of cinders, for the products of combustion were not better utilised at their exit from the furnace than in ordinary cases.

These experiments show us then that if we add to the advantages already produced by the use of lighting gas, the special economics arising from the application of the new mode of heating with economic gas under constant volume previously calculated, we will certainly reach a mode of combustion perfectly reasonable and most economical.

In fine, in attempts to manufacture steel with gas, we have understood in the same establishment that the net cost price of gas manufactured in gasogenes with forced air analogous to that I use averaged under $\frac{7}{10}$ centime per cubic meter at 0, gross price with coal, 20 francs per ton.

I sum up here the composition of the gas that I use taking injection and decomposition of steam as equal to 33 kil. to 100 kil. of burnt coal:

		Weights. kil.		Volume at 0° and 760°. m.c.
Arising from the steam ..	C^2H^4....	14·6668	..	20·51300
	CO	51·3280	..	41·06200
Arising from the air	CO	71·6700	..	59·73600
	Az.....	142·8500	..	113·77900
Composed Water		5·0000	..	6·20200
Tar.....	C^4H^4....	6·0000	..	3·95300
Lighting Gas.....	H.....	0·2400	..	2·67997
	C^2H^4....	14·1600	..	19·81414
	C^4H^4....	1·6000	..	1·26475
	CO.....	2·2600	..	2·07858
	AzH^3....	0·5000	..	0·64882
	HS.....	0·2000	..	0·12985
	CO^2.....	0·7000	..	0·35407
Total.....		313·5148		272·18518

The density of this gas at 0° and 760° will be equal to 0·8908°, and the weights of the cubic metre 1·1518 kil.

If now we suppose a gas produced without injection of steam, we have for its composition:

	Weights. Kil.		Volume at 0 and 760. m.c.
CO.....	151·66670		121·333
Az.....	290·14494		231·099
Water.....	5·00000		6·202
Tar C^4H^4.....	5·00000		3·953
Lighting Gas	20·00000		26·97018
	471·81161		389·55718

The density will be equal to 0·9367, and the weight of its cubic metre 1·21115 kil. On the other hand, if we compare the calorific weights of these three gases we find:

	Per Kil.		Per cubic meter.
For the first	2462·80		2836·9
,, second	1361·20		1648·6
Lighting Gas.....	10923·18		8100·2

We have thus all the general data required for the settlement of the different particular cases.

XXVII.

I will finish these considerations by summing up the various advantages that the application of this system of heating brings us.

1st. The possibility of using under any circumstances all sorts of fuel.

This point is very important; it constitutes along with the economy of fuel produced, the social side of the question, in putting off as far as possible the failure of the supply of fuel.

2nd. Longer duration of the brickwork in metallurgical furnaces, such as the metallic forges of tubular generators, seeing the absence of an excess of oxygen, the principal cause of oxidation in this case.

3rd. Possibility of regulating at will the intensity and nature of the flame, consequently the conduct of the heating apparatus.

4th. In the manufacture of iron and steel, great economy in the waste products, improvement of quality.

5th. In marine boilers the saving realised on the carbon allows a smaller quantity to be stored, and thus the useful tonnage of the vessel to be increased.

6th. This system of heating enables us to reach higher temperatures than those hitherto reached in manufacture.

7th. The feeding water thus heated in the regenerator about 100° becomes much less encrusting. The carbonic acid that it encloses is practically expelled, and the carbonate of lime which is found dissolved by this excess of acid is deposited to the regenerator in place of proceeding to encrust the boiler.

The last consequence is the lowering greatly the chances of explosion of the generator.

8th. Smoke suppression, as any one can convince themselves, is really complete. This gain amounts often to large sums.

9th. In fine, the utilisation of the fuel being greatly increased, the result is a saving of fuel for industry, varying according to the application, but always very important.

It is principally due *to the complete combustion obtained under constant volume and to the prevention of cinders.*

General Summing up and Conclusions.

In the first portion of this memoir I have studied and examined the present state of industrial heating; I hope to have shown how much in general it was imperfect, and that further the principal enemy to fight was the natural draught produced by the chimney.

I have not hesitated to conclude that the total loss exceeded on an average 70 per cent. of the carbon placed on the grate, less than this figure in certain cases, more in others.

Led by this annoying result to study the means of remedying it, I have arrived in the second place at establishing, by a succession of deductions resting some on purely theoretic considerations, others on the facts of experience, that the evil principle rested in the faculty possessed by the products of combustion of expanding freely.

A fact gained by industrial practice and known to all, namely, the high pressures gained by heating under pressure, has there

found its natural explanation. I have shown that without requiring to have recourse to high pressures we reach an analogous result in resisting by means of the hydraulic regenerator the expansion of the burnt gases.

The whole of this theoretical part may be summed up thus :—

If we compare two heatings made, the one at constant volume, the other at variable volume of the burnt gases, the temperature produced in the first case is superior to that produced in the second, all other things being equal.

And that because :—

If we allow the burnt gases to expand freely, and their initial pressure diminish, there is absorption in the latent state of a quantity of heat not yet exactly determined, but always important. If, on the other hand, we prevent this expansion this heat will appear in the sensible state, and the manufacturer may utilise it.

Seeking then the means of obtaining practically and simply a complete combustion and this constancy of volume of the burnt gases, I have come to propose the application of a new system of gas-heating comprising three principal parts.

The *gasogène*, an apparatus already known under various aspects, on which I have not insisted, reserving to myself to give information on the forms and sizes that I adopt in fixing it for the manufacturers who may wish to communicate with me for the application of the new system.

In the second place, the *blast-pipe* or *smoke-consuming apparatus*.

The forms that it takes are various, according as it is a question of metallurgical furnaces, tubular steam boilers or not, &c. I have not described in detail these different forms either, the previous observation applying as well to this apparatus as to the gasogene.

In fine, the *hydraulic apparatus*, intended to produce constancy of volume and named *regenerator*, because it really regenerates several heats lost until now in the latent state, and that I have enumerated.

This apparatus, all in sheet-iron, is very simple ; it is, as shown in the sketch, a simple metallic tank divided into two compartments.

Its use is very simple; it adapts itself readily in all cases; its presence does away with the chimney.

If we examine the whole of these three apparatus we arrive at this conclusion, that the application of the new system to all industrial heatings can be rapidly made at little cost, without changing appreciably the old apparatus.

Without entering into the details of a complete classification, I will say that the loss caused by the application of the mode to a force consuming 100 kil. of coal per hour does not exceed 1,000 francs. We must add to that a small ventilator, driven by a machine of two or three horse power at a maximum.

In conclusion, I will add that I think I have shown that the application of this system of heating cures as completely as possible the different causes of the losses suffered until now in manufactures, and that if we add to the important saving of fuel that it effects with certainty and rationally, the other advantages, numerous and often also very considerable, enumerated in pages ——, that if we consider, in fine, that its application is everywhere possible at small cost, we arrive at this conclusion, that its adoption, or at least its trial, ought to be made by every manufacturer anxious to show himself a lover of progress, free from routine, and careful of his true interests.

PAUL CHARPENTIER, Civil Engineer.

Correspondence.

STATISTICS.

BIRMINGHAM, MARCH 2, 1874.

TO THE EDITOR OF "THE SUGAR CANE."

On glancing over the number just to hand, I see a table of Sugar Productions, 1853 to 1873, which appears to give a very erroneous idea of the course of sugar production.

English Guinea is given as 13,556 tons for 1871. I have not the particulars of that year, but 1873 was 94,000 hhds.

What is meant by the English Antilles I do not know, but, except Jamaica, I believe the produce of all the English Islands increased from 1853 to 1863.

I have no particulars of the crop of Porto Rico for past years, but I believe it is three times what it was in 1853; 1870 being 135,000 tons.

I call your attention to these errors, though the paper has a signature; because, if not corrected, we shall probably see these figures quoted with the authority of *The Sugar Cane*, and the following erroneous conclusion given, viz.:—that the production of Porto Rico and the English Islands decreased from 1853 to 1873, whereas the reverse was the case, I believe.

Yours truly,

C. D. Sturge.

METHODS OF PURIFYING CANE JUICE.

To the Editor of "The Sugar Cane."

Sir,

In reply to the invitation of your correspondent, C. M. Hjardemaal, for an "explanation of the means by which the indicated advantages of my process of purifying cane-juice are to be obtained," I beg to state that my arrangements for patents in foreign countries are not sufficiently complete for immediate compliance. Therefore, it may be desirable to communicate with me direct.

I have no doubt that such an effectual separation of the impurities as can bring the juice "clear, bright, and of the colour of pale sherry," to flow on to the Concretor table with all the regularity of which the mill is capable, must result in that better quality of pure sugar, which your correspondent evidently desires.

I am, yours obediently,

W. Eathorne Gill.

South Hill Park,
Hampstead, London N.W.

Stocks of Sugar in the Chief Markets in the World on the 1st February, 1874, for Three Years, in thousands of tons, to the nearest thousand.

	1874.	1873.	1872.
Great Britain	189	143	108
France	225	160	71
Holland	36	46	35
Germany (Zollverein)	51	49	36
Six other *entrepôts*	11	8	4
Total in Europe	512	406	254

Consumption of Sugar in Europe for Three Years on the 1st February, 1874, in thousands of tons.

	1873.	1872.	1871.
Great Britain	794	715	662
France	259	224	327
Germany (Zollverein)	261	239	212
Holland	28	23	20
Six other *entrepôts*	103	95	113
Total in Europe	1,445	1,296	1,334

Estimated Crop of Beet Root Sugar on the Continent of Europe, for the ensuing Season, compared with that of the three previous Seasons.

(From Licht's Monthly Circular.)

	1873-74.	1872-73.	1871-72.	1870-71.
	Tons.	Tons.	Tons.	Tons.
France	400,000	259,000	189,000	263,000
Germany (Zollverein)	285,000	409,000	335,000	289,000
Austro-Hungary	175,000	214,000	162,000	182,000
Russia and Poland	150,000	150,000	90,000	135,000
Belgium	68,000	76,000	72,000	56,000
Holland and other Countries	37,000	35,000	25,000	17,000
Total	1,115,000	1,143,000	873,000	942,000

SUGAR STATISTICS—GREAT BRITAIN.

To MARCH 14TH, 1874 AND 1873. IN THOUSANDS OF TONS, TO THE NEAREST THOUSAND.

	STOCKS.						IMPORTS.						DELIVERIES.					
	London.	Liverpool	Bristol.	Clyde.	Total, 1874.	Total, 1873.	London.	Liverpool	Bristol.	Clyde.	Total, 1874.	Total, 1873.	London.	Liverpool	Bristol.	Clyde.	Total, 1874.	Total, 1873.
British West India	13	3	..	17	33	24	12	4	1	6	23	16	19	2	1	7	29	29
Cuba	1	4	1	12	18	11	1	1	2	3	7	4	1	1	3	11	16	10
Porto Rico, &c. ..	..	6	..	3	9	7	..	5	..	..	5	6	1	6	..	..	7	5
Brazil	5	26	..	5	36	26	3	15	2	3	23	20	2	10	2	2	16	15
Mauritius	4	..	1	2	7	11	3	1	3	4	11	15	2	1	2	2	7	11
British East India	14	4	..	..	18	18	3	1	..	..	4	12	4	1	..	..	5	7
Manilla & Java ..	35	16	1	4	56	31	8	6	5	5	24	14	4	4	6	3	17	13
Beetroot, &c.	10	1	1	6	18	10	19	4	3	10	36	32	15	5	4	10	34	42
Total, 1874 ..	82	60	4	49	195	138	49	37	16	31	133	119	48	30	18	35	131	132
Total, 1873 ..	59	39	5	35	57 increase		37	33	17	32	14 increase		45	24	17	46	1 decrease	

THE STATE AND PROSPECTS OF THE SUGAR MARKET.

There has been little change in the state of the Sugar Market since last month. The position it is in at present with regard to the doings of the new Government is showing itself outwardly in an increased indisposition on the part of the trade to do business. All that can be done just now is to wait patiently, and as the result will soon be known—the Budget being promised for the 16th April—business will then, it is to be hoped, regain somewhat of its wonted alacrity.

At the beginning of the month business was almost suspended, but is now somewhat better.

A petition in favour of the abolition of the duties is at present in course of signature, of the effect of such an abolition there is no need to speak, and it is only to be hoped that the Government will see that it is to their own interests as well as to the interests of the refiners to grant it. We are also glad to see that on the other side of the water matters have come to a definite conclusion. The French have decided upon refining in bond. There is little to be said on this subject yet. They must either have let things remain in *statu quo* or adopt refining in bond; and, very sensibly, they have chosen the latter, the results of the change will very soon show themselves.

The imports for the eleven weeks show an increase of 15,924 tons, the deliveries for the same time showing a decrease of 368 tons. Whilst up to the 14th March the increase in stocks, compared with the corresponding date of last year, amounts to 56,576 tons.

The following are the quotations of the prices current this day:—No. 12 Havana afloat for the United Kingdom 24s. to 24s. 6d., showing a fall from 27s. current same time last year. Fair to good Refining Cuba Muscovadoes 20s. to 21s., as compared with 24s. to 24s. 6d. in 1873. Middling to good Brown Bahia 17s. to 18s., contrasting with 19s. 6d. to 20s. 6d. last year. Good to Fine Brown Pernambuco 19s. to 20s., showing a fall of 2s. from last year's prices.

Stocks at the four chief ports have considerably increased during the latter end of the month, whilst at the beginning the increase was very small.

It is to be hoped that very soon an impetus will be given to the trade; that at any rate the sluggishness now prevalent will discontinue. If, whilst France opens her arms to more liberal measures regarding her sugar manufacturers, the Conservative English Government will do similarly, there will be little need to complain.

THE

SUGAR CANE.

No. 58. MAY 1, 1874. Vol. VI.

☞ The writers alone are responsible for their statements.

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THE SUGAR DUTIES.

With nearly six millions of a surplus the Conservative Government take the field. This is the largest any Minister has ever had to deal with; how is it to be treated? It is very tempting to make an analysis of the Budget which has just been laid before the country, and to examine as far as we could the temper and power of the new Chancellor; but this is not the place for such an analysis, which must be treated of otherwhere and by other hands than ours. Still we have to do with part of this Budget, and that part is as satisfactory as we could well wish.

There are certain trammels which hamper human beings very considerably, and one of these is a species of heavy weight which hangs over them in the form of indirect taxes. Of these taxes the most important are those on articles of food. These are really grinding weights: they press heavily upon us, and we cannot throw them to one side, or rise up buoyantly under them. Wherever we turn, there they are staring us in the face; ghosts which continually haunt us and cannot be exorcised save only by those who sent them. One of the weights *has* been lifted off: one of the ghosts exorcised. The tax upon sugar has been abolished! The 1st and the 20th of May will make a great difference to us now. On the 1st the duty on raw sugar will be taken off, being followed on the 20th by the duty on refined.

In Sir Stafford Northcote's financial statement on the 16th April, he makes the following statement :—

"It would be expected that in remitting direct taxes the Government would also propose a remission of indirect taxation. He did not think it could be admitted as an inflexible canon that remission of direct or indirect taxation should go *pari passu*, and that it was necessary because a million was taken off one that a million should be taken off the other. This implied a system of taxation so fairly balanced that the removal of a portion of one source of supply would destroy the equilibrium of the whole, and he could not say that our financial system was in this state. He thought that the leading principle to be kept in view was to consider in what direction they could do most good by any remission, and not to trouble about whether it was a remission of direct or indirect taxation. The object to be kept in view was to do that which would be most advantageous to the whole community. The Government had given careful consideration to all the great articles of consumption liable to duty, and they had arrived at the conclusion that the sugar duties should be abolished. (Cheers.) Four years ago the right hon. gentleman (Mr. Lowe) had reduced the sugar duties one-half, and at that time he said that he supposed that would be the final remission he could recommend ; but two years afterwards he found it necessary to revive the question, and last year the sugar duties were reduced by one-half the amount which was left. The amount of these duties bore but a comparatively small proportion to the cost of collection, and gave rise to great annoyance and injury to the trade, and therefore, on the principle that these duties did more harm than good, they had been selected as the subject for remission. He had stated that sugar was an article of consumption of the first magnitude, and next to corn was the article which was most largely produced in this country, and if the duties were abolished there was every prospect that England would become a great sugar-making country. He considered it to be of the greatest importance they should select some article for remission which would have the effect of stimulating and supporting the commercial interests of the country, and had it not been for this consideration, he should have accepted with more hesitation than he had done the estimates of the heads of the inland revenue department. Thirty-five years ago the then Chancellor of the Exchequer, in a time of anxiety and pressure, thought he would supply a deficiency in the revenue by increasing the duties of the Customs and Excise, and failed in the attempt. He (Sir S. Northcote) then might hope by relieving the duties of Customs and Excise to facilitate and increase the trade and commerce of the country, and thus in another way support and strengthen the revenue. There was no argument that could be adduced against the abolition of the sugar duties save one, and he admitted it had

some weight. It was that in doing away with those duties they would be cutting off a permanent source of revenue which they might some day or other regret. He could not deny that it was more difficult, when there were duties on so few articles, to cut off one of those sources of revenue, than it was when the duties were much more numerous. But, looking at the progress of the country, he could not believe that they would be left without plenty of channels from which the revenue could at need be replenished. He would point to the increased consumption of spirits. It might be said that it was dangerous to rely upon that increase, and that a check would come which would cause that enormous source of revenue to fail; but he asked, how could it be expected to fail? Why should not spirits be able to bear even an increase of taxation? (Hear, hear.) This was a source of revenue still open to an emergency if it were possible to increase the taxation without diminishing the consumption. He apprehended that the consumption of spirits could only be expected to fall off under two sets of circumstances—first, through some general failure in the ability of the people to purchse spirits, and next through some great change in the habits of the people, so that they might be induced to abandon the use of such enormous quantities. But the first reason would tell on all sources of consumption, as well as on spirits, and with regard to the other cause, an increase in the temperate habits of the people, the amount of wealth that would thereby be accumulated would be such as to utterly throw in the shade the revenue derived from spirits. The right hon. gentleman (Mr. Lowe) in reducing the sugar duties last year alluded to the complications of scale which existed, and to our negotiations with foreign countries. It had been suggested that if other duties were abolished it would be left open to France and other countries to levy their duties on sugar in such a way as to injure our refiners. He was afraid that, however we worked our treaty with France, it would always be in the power of the French Government, if they chose, to give their refiners an advantage over ours. By far the best way of dealing with the sugar duty was to get it entirely free. (Cheers.) The paralysis that had fallen upon the trade since January, when the announcement was made of the probability of its being taken off, showed that this was the best course to adopt, and when they remembered the enormous efforts that were made by some people to introduce sugar with the appearance of a fictitious quality, to make it appear worse, in order to have a lower rate of duty imposed, and the discouragements which attached to the various modes of improved production. He thought they might anticipate for sugar a very great future by setting it entirely free. (Cheers.) That would take off £2,000,000. There would be a difference in the date of taking off the duty. For raw sugar the duty would be taken off on the 1st of May, and for refined on the 21st of May. In connection with this subject it would be necessary

to impose a small duty on plums—(laughter), and that was owing to there being a tax on sweets and confectionery, which it would be necessary to equalise with plums coated with sugar. The excise duty upon sugar used in breweries would have to be raised, in order to put it on an equality with malt. The House was now put in possession of a reasonable amount of disposable surplus. But there still remained £492,000 to be disposed of, so he had mentioned that he might as well inform the committee at once that the malt duty was too much to be satisfied with the surplus he had still left. (Laughter and cheers.) He regretted that, because he was by no means insensible to the arguments used against the malt duty, in its incidence, but the question of abolishing it was too large to entertain at present. There were very great difficulties in the way of improving the mode of its collection, but he might say that information had been collected from foreign countries showing the methods of taxing beer and malt, and by studying these some of the difficulties might be got rid of."

This is a grand beginning for the new Conservative Government: it is a true Liberal policy, and of course the whole nation will see that, in taking up the policy proposed by Gladstone, they have—as they have always hitherto done at the beginning of their reign—shown a true appreciation of the talents of the previous Government. We do not say this in any mean spirit: we do not wish to deprive them in the smallest degree of their honour in acting as they have done; we merely wish to show, as we have already said in a previous article, that the true Conservatism is the true Liberalism.

The freeing sugar from the trammels of taxation is about the only way to help the trade against the immense advantages the French have over us; and, as the Chancellor very truly says, "He was afraid that, however we worked our treaty with France, it would always be in the power of the French Government, if they choose, to give their refiners an advantage over ours." Had he seen fit to have kept the sugar tax on, or merely to have reduced it, not even the new method (for France) of refining in bond would have placed us upon an equality. Abolition of taxes is much the quickest method of severing that Gordian knot which the various Conventions have been trying to unloose. It could never have been untied—it must have been cut sometime or another, and the sooner it was done the better.

We do not think the right hon. gentleman need be afraid of the change which would have to be looked forward to in raising, at some future time, the taxation of spirits. We refer to the change which might occur from failure of the people of this country to be able to purchase spirits; or on the other hand, an increase of temperance: at least, an increase such as seriously to affect the income which the Treasury would derive from that article!

It can scarcely be said that temperance is the besetting sin of this country! Instead of, as its sanguine supporters assert, its being on the increase, we are afraid it is on the decrease. We are sometimes not at all astonished at this increase of drunkenness when we consider how towns are increasing in size; how the "slums" are being overpopulated; how filth and disease go hand in hand. When we consider this, we are not at all surprised that the opiatic-devil whisky is consumed so much—how the god that brings oblivion in his train is so much worshipped. The way to decrease drunkenness would be to make the inhabitants of the lower parts of a town keep, under a heavy penalty, their houses and streets clean, and let us also add *themselves* to this category; but as this decrease would be followed by a corresponding decrease in the revenue, we do not suppose Government will be such enemies to themselves by doing such an act. They might think of it, however, for the benefit of others!

The decrease of revenue on the one hand would, however, be neutralised by a more than corresponding increase on the other, and instead of failure there would be riches; instead of filthiness there would be purity; instead of shame there would be graciousness and nobility.

When viewed seriously, a study of the Budget reveals strange sub-histories in the history of a nation. It is the pulse of the peoples of a country, and by placing the finger on this ever-beating vein we can watch the risings and fallings, the changes and counterchanges of the country's life.

A study of the increases and decreases of the revenue tells a tale distinct, definite, unfailing, unliable to error, and what is required is a clever physician at the pulse, who can treat the diseases of a complex life.

Disease has lately taken hold of the sugar trade—its blood has become stagnant. It heard rumours, and therefore became afraid; but let us hope now that ere long it will be sent spinning on in a well-oiled groove, and that its failing life will return with redoubled vigour, and strength come once more to the lately almost unused limbs.

ON SUGAR MANUFACTURE.

To the Editor of "The Sugar Cane."

Sir,

I am in receipt of letters repeating the anxiety of the writers for some further information which may help them to a decision in the matter of sugar manufacture; recent legislation having opened our market to the competition of the whole world. As your intelligent pages are suggested to me, subject to your generous permission, I beg to offer the outline of what I have not time, at present, to fill in to completion.

My aim has been, the purification of cane-juice. It is well known, that the nearest approach to purity, in the juice, can lead us to expect *the largest quantity, of the purest quality of sugar;* of course this can occur only when properly reduced by evaporation to the required density for suitable crystallization.

Take the facts as they happen, and we do but remind the managers of sugar estates, that cane-juice, as it flows from the mill, is not pure, it is not a simple solution of sugar in water, it contains more, and this more we look on and treat as impurities. Some of those impurities are liquid, as albumen, the albumenoids, gummy matters, &c., &c., others are more or less solid, as cellulose, known technically as "cush cush," the *debris* of cane, mineral matters, &c. These have been boiled together; the product, in many instances, would almost baffle description, when we must recognize it as sugar; hence the necessity for the refiner.

A space of time intervened between the expression of the juice and the boiling of it, affording opportunity for further complication

by fermentation, which rapidly sets in. This further impurifies the juice with organic acids. Lime has been added so regularly to neutralize these acids, that men came to believe that lime is essential to sugar. It can be proved to be destructive to sugar, when boiled together with the usual organic impurities in the juice. It was Pelouse who first observed, that when sugar was put in contact with lime and a nitrogenous substance, as albumen or animal matter, that lactic fermentation ensued, and lactic acid was the result. Some resigned themselves to this loss of sugar, as to the inevitable. Other acids may be as easily accounted for. The fact has been frequently laid bare by the scientific chemist, that the tendency of albumen and the albumenoids to pass rapidly into putridity became the proximate cause of fermentation in cane juice, which fermentation the sugar fed and perpetuated. This process would go on unchecked until all the sugar became vinegar. Of course, if we remove the cause, the effect follows after. Coagulated albumen is without activity, we say it is then inert. The white of an egg is concentrated, pure albumen. If we boil the egg, we coagulate the white of it, and boiling the juice was supposed to coagulate the albumen in the juice. That supposition occurred in the absence of a knowledge of the different action of that temperature (212° Faht.,) on the concentrated albumen of the egg, and the dilute albumen of cane-juice. The white of an egg is coagulated at 160° Faht., and the temperature of coagulation rises with the degree of dilution. Albumen is often detected in the lower grades of sugar, as it comes into the hands of the refiner, even after the amount of boiling to which that sugar had been necessarily subjected.

As boiling failed to satisfy the requirement, chemicals were resorted to, poisons have not been excluded from the list, although as promptly omitted. Sulphurous gas obtained a place, by reason of its bleaching power over organic matter. Demerara rang with its praises towards the end of 1872. As a proof, we had it on good authority, in the public papers, that "301,700 gallons of cane-juice produced 256,743 lbs. dry sugar," when treated with this gas. It may be desirable to preserve those figures, as we are on the eve of other figures, which are expected to result from my

process, conducted under superior auspices. Some are perpetuating the use of this gas for want of a better mode of treatment.

Filtration has been attempted in all its interesting variety, but the impurities would accumulate on the filter, until its avenues were completely closed, and no more juice could pass.

"Despair sat moping there."

By my process the difficulty is over come, the filter of sand, preserves and continues its power; for a new character has been given, promptly, to those mischievous liquid impurities. They are now no longer liquid but solid, they do not lay down to cover the filter, and impede, and actually stop the desired process of filtration. They are no longer diffused, but concentrated. They are deprived of their gummy character, they are coagulated, to rise up and float on the surface, to be removed with ease and at leisure, as scum, having been deprived of their water of fluidity by galvanism. The juice remains as cold as at first, and as free from acidity. Of the ability of galvanism to do all that we require, I might adduce the experience of our first chemical authorities in confirmation.* It will be sufficient for my present purpose to quote Turner, who says, "Galvanism is one of the most elegant and delicate tests, whi h we possess, of the presence of albumen." Of this great chemist it is said, that he never expressed himself positively on anything, until he had himself proved it to be as he represented. It was Professor Brande who first employed galvanism for this purpose, he required, many years ago, to decide the composition of saliva. All his chemical tests failed to satisfy him. As *a dernier resort* the professor tried galvanism, and was now enabled not only to detect the small quantity of albumen, but actually to collect and decide its proportion to be 7 parts in 1,000 parts. Modern chemistry in skilful hands has recently confirmed the perfect accuracy of this result. Here we may perceive the ability of galvanism, not only to detect, but actually to coagulate all the albumen even when mixed with, and extremely diluted by water, as it is also in cane-juice. The experiments, with galvanism, on

* Albumen may easily be coagulated by means of galvanism.—*Med. Chir. Trans.* ii., 166.

cane-juice, in Demerara, and in my absence, tend to confirm this interesting fact. My appliances, for this purpose, are contained in a wooden tank. Into this tank I quickly get the juice, as it comes from the mill. The juice may flow into the tank, or it may be lifted or forced there by a pump, provide there be no delay. Galvanic action is spontaneously set up there. The following portion of juice plunging into that which preceded it—which is already charged with galvanism—partakes at once of the like character, without even the touch of a finger, or the addition of any thing for weeks together. The hitherto formidable "cush cush," and other particles of cane, with any earthy matters, fall down into a "cush basket" waiting to receive them. This basket is emptied periodically, without interrupting the flow of the juice through the tank more than one minute. All tangible matters are held imprisoned there for the "cush basket," whilst the juice filters away through sand into the body of the tank, which is its second stage. Galvanism pervades the juice there also, and any remaining impurity rises coagulated to float as scum. Every thing is quiet here, and the pure juice escapes silently, first by descension and then by ascension through the sand. It can be made to undergo an additional filtration in the same tank, by ascension through wood or animal charcoal, according to the quality of sugar required, before it can escape from the tank.

So long as juice is flowing through this tank, so long is galvanism developed, to pervade all the juice there, and act instantly on the impurities of the incoming juice. Fermentation is thus effectually and instantaneously stopped; acids are not now composed there, and it is evident that the necessity for lime cannot legitimately occur. The test paper should be of a faint rose colour.

The one man who changes the "cush basket," also scums off these floating coagulated impurities. His wages included and completed the current expense of my process, where five tons of sugar were made daily.

It may be doubtful policy to attempt to compete with the home refiner in white sugar. The grocer compares the two, and the planter suffers with his best article. What the grocer wants, is

precisely that delicate yellow article, which juice purified by my process is capable of affording, with a greater amount of profit for the planter. The value of the now considerably increased product can be added to that better price, which is always ready for the required quality. The grocer will have it if he can.

The juice escaping from one end of the tank, as fast as it enters at the other end, flows on into the clarifier. Here I would invite the greatest carefulness. The temperature is promptly raised to about 170° Faht., and then should progress very gradually to boiling. The scum begins to form at about 190° Faht., and then the temperature should be regulated by the amount of scum, so that it does not rise rapidly, but slowly. The reason for this desirable amount of care will presently appear. This scum is mainly composed of starch granules, which are so small, as not to be detected by the unassisted eye. They even pass the repeated filtering unchecked. Here they expand by heat to 30 times their original bulk, to rise and accumulate on the surface of the liquor in the clarifier, and be removed as scum. If we do not diligently watch over and remove this scum, but leave it until the scum "cracks," or the liquor boils, then these starch granules burst, and we do not meet with their contents until we see the slimy molasses of which the escaped starch granules are the foundation or origin. Hence the necessity for careful vigilance in directing the operations in the clarifier. Here the juice is to be scummed with a suitable fine scummer, not "brushed" off. When perfectly clean, after boiling half an hour, the juice is to be run into whatever evaporators,—"copper wall" or other,—as may be provided, where the labour has been already reduced to the minimum.

Although my purifying process may be complete at this stage, I am unwilling to leave the result to accidental treatment for a good or a bad product. For, sugar is well-known, chemically, to be a very tender substance. The bond of affinity is feeble which holds together the elements of sugar, so that they are easily disarranged whilst in the liquid state, at an elevated temperature. It is possible there to rearrange these elements, and bring them together in other proportions, to become something else, that is not sugar. Take a glance at sugar, it is composed of $C_{12}H_{11}O_{11}$ and now

at glucose, it is composed of $C_{12}H_{12}O_{12}$ and note the trifling difference, say one atom of water, no more. Starch, too, is very similar, differing only in proportion, $C_{12}H_{10}O_{10}$. As the changes to which I have alluded are facilitated, if not controlled by the presence of organic matters other than sugar, such as the impurities already alluded to, which are common to cane-juice; we are naturally jealous of their presence, that is, if we desire to retain possession of all the sugar in the normal juice. Aware of these things I have preferred to operate immediately on the cold juice, and also watch over it in the clarifier, as it *slowly* developes the scum there, to remove it.

To take a step further in this direction the juice should be evaporated with as little heat, and as little motion as possible. This position involves the important question in relation to plant, the ability to accommodate the proper amount of suitable evaporating power to the quantity of sugar produced. Having a sufficiency of that power in many pans, and not concentrated in one or two "tayches," named "frying-pans," by Dr. Ure; we should evaporate at 210° to 212° F., for the best sugars that open pans can afford. We might rise to 225° F., if the quality of that product suits the requirement; in fact we may raise the temperature of the sugar to that degree without positive injury to the sugar. Whenever we exceed 225° F., we do so at the expense of quality, in colour, and beauty of crystal. We are aware that active-minded men get impatient when they do not see a congenial progress; they are not always disposed to appreciate fully their best index, the thermometer. Fletcher & Co. very properly attach a suitable thermometer to each of their excellent multitubular pans. Activity often satisfies, even when relative quietude is most suitable, when evaporating cane-juice, and an heroic desire for quantity, tends to obliterate their appreciation of quality. I have purposely exposed what might become a serious error if indulged in, particularly now that we are entering on a free competition with the sugar producing world. Quality will henceforward control the sale of sugar. Quality is therefore of sufficient importance to become my apology for indulging in these remarks, seeing

it should command the utmost solicitude in the manufacture of sugar, because it must decide the question of profit or loss to the owner of the estate. In a word, those who study quality with success, may command the market at any time, whilst neglect of quality must be the prelude of failure. We must have excellence.

It had almost escaped me to notice my preference for a "rather low strike," that is, not over boiled. I am also aware of the possibility of imperfect crystallization as a consequence and a superior crystal, that is, all the sugar may not be perfectly crystallized at the same time, and we get liquid sugar draining away, mistaken for molasses. This liquid sugar is very likely to reduce the value of the crystallized portion, if mixed together, mortar fashion, when "potting." For this liquid sugar becomes viscid as it cools, and of course does not entirely drain off on "the stanchions," nor even *en voyage*," but enough remains to affect the colour and reduce the value of the more perfect sugar in the esteem of the buyer. Therefore, the still liquid portion of sugar should be drained from "the cooler," before the crystallized portion be disturbed for removal. As the sugar produced from juice, purified by my process, contains the minimum of molasses, if any, I prefer that the liquid portion be returned to the "copper wall," and thus secure the considerable increase in the amount of sugar product, which I have obtained on previous occasions.

The "Concretor," as an evaporator, embodies an interesting philosophic idea, which deserves success. I can have no doubt that its products would become more valuable than they are, if the purification of the juice were more perfect. Experience teaches the important fact, that if we do not succeed in purifying the juice *before heat is applied*, it becomes a very difficult, and very expensive process to succeed afterwards, with a diminished sugar-product. Whereas, a simple and inexpensive process of purification, may be sufficient at the proper time. Thus, a valuable increase in the quantity of purified sugar, is to be found among the rewards of a judicious treatment of Cane-juice.

I have no time to entertain the V. P. process now.

W. EATHORNE GILL.

South Hill Park, Hampstead.

THE MORAL INFLUENCE OF THE ABOLITION OF THE SUGAR DUTIES.

The Chancellor of the Exchequer in his financial statement of the 16th April opens up, in one short sentence, a wonderfully large path for political economists to investigate. He says, "He apprehended that the consumption of spirits could only be expected to fall off under two sets of circumstances—first, through some general failure in the ability of the people to purchase spirits, and next through some great change in the habits of the people so that they might be induced to abandon the use of such enormous quantities."

We think it might be interesting to examine more closely these two points; to inquire whether these are emergencies which are at all likely to come forward; in fact to see if the abolition of the sugar duties will help in any way towards the decrease of drunkenness.

These are wonderfully important points, not only from an æsthetic but from a material point of view; not only of great value socially but in business.

Let us take the first: *Some general failure in the ability of the people to purchase spirits.* This of course rises again from one of two causes. The increase of taxation on spirits thereby rendering their price too high for the wages of the working men; or the lowering of the working-man's wages to an abnormal extent; and we might even had to this, a mixture of these two causes.

We use the term "working-man" advisedly, as it is upon this class the weight will fall. The rich, or indeed the middle-classes are too far beyond the necessity of absorbing the immense amounts of drink which the working-man consumes.

These questions become very complicated ones. Before we can determine on any thing we must first enquire into the cause that leads men to drink over-much. To our mind this is a very easily answered question, if we look at the character of the people who do over-drink, and their style of eating.

We are well aware from experience that one of the first effects of air-poisoning—living in a vitiated atmosphere, is the inability to

eat much. A certain amount of fuel in the form of carbon must be absorbed in order to supply the human engine with working power. That fuel can be supplied in two ways, either by solid food, or liquid food, that is liquid rich in carbon, such a liquid we possess in "spirits." But the latter species of food is more easily taken than the former. As the solid food has to undergo a certain amount of chewing and digestion before it can be absorbed by the body, whereas the latter merely requires absorption. Now men working in vitiated atmospheres, living in holes little better than dog-kennels, inasmuch as pure air and pure light never come near them, soon find the food digesting apparatus get out of work. It loses its power, it can only digest a certain amount of food, so that the amount of fuel it has given to the body is not sufficient to keep the whole body in full swing.

But again, not only have the "spirits" a certain quantity of latent nutritive-power, they also have the power of, *to a certain degree* assisting digestion. To a certain degree, observe, and that degree is comparatively small. So that should working men take a very small amount of spirits (suppose we say in the form of beer) they are assisting digestion.

But spirits have another property besides this. They have an action upon the pepsin of the gastric juice. In small amounts this action is insignificant, but large quantities destroy the pepsin, and by this destruction its power of dissolving food disappears. So that not only is it a power in assisting digestion, but it is a greater power not only in preventing it, but in destroying the stomach and rendering it unfit for the performance of its duties.

It is thus evident that the greatest amount of strength can be obtained from animal food, without the use of stimulants, except in some cases of invalidism, when the stomach requires some slight excitement. Thus then we see in the case of the working man the causes leading him to over drink. He lives in impure air, his food at times of the very meanest description, being such that he can not obtain sufficient nourishment from it, whilst a few glasses of whiskey or beer give him a fictitious strength, which leads him to suppose that it is to that, and that alone almost, he must look in the future for work-force.

These two causes then react upon each other. Want of sufficient strength-giving food makes him take to fictitious-strength-giving spirits, whilst an over indulgence in the matter gives him a distaste for solid food, and indeed has taken away to a great extent the ability of dissolving and absorbing it.

This then is to our minds the opening up of the question, it is the starting point of the whole. We see how the working man is led to drink, and how *in reality* it becomes a necessity for him, as even if he would he is unable to digest solid food. We must now retrace our steps to our original starting point, and enquire into the probabilities of a "general failure in the ability of the people to purchase spirits."

This we have already shown might arise from two causes. Let us consider them together.

1st. Increase of taxation above workman's power of purchase.

2nd. Lowering of workman's money-power.

We have already seen that the use of spirits, whether used as beer, wine, whiskey, or brandy, can enable a man to do a certain amount of work for a certain time. Now let us see what the effect would be were the duties on spirits to be raised. Naturally one of two things would happen. Either the workman would cease to some extent the use of the stimulant and return to the more solid food, or he would drink as much as formerly, thus abstracting from his wages as drink-money what he was before accustomed to spend on some solid nutriment. This is certainly what would happen. But again, without that amount of solid food he could not go through the same amount of work as formerly, so that he must either cease work or be content with a smaller amount of fluid-food, fictitious as it is.

But again, a fall in workman's wages means a falling off in the prosperity of the country; which may again mean a lowering of the price of food. So that suppose we have at the same time a falling off in the price of food and an increase in the price of spirits we may be able to gain what we have been striving after in this country, an increase in the amount of solid food used and a decrease of drunkenness.

Let us take for example the last two years: we have seen an increase in the price of almost every article of consumption save spirits. And in speaking of a non-increase in the price of spirits we do not mean the substitution of a lower kind of spirit to be sold at the same price that a better kind was formerly sold at, as there is little doubt a man will buy an inferior spirit at his ordinary price, so that he gets an equal amount of spirit as formerly, rather than give a higher price for a better article. But along with this increase of price of the various articles of solid food, we have seen we believe *no* decrease in the amount of drunkenness, in reality we believe we have seen a decided *increase*. Why should this be so if our theory be correct? In the first place the wages of workmen have increased to an enormous extent. Therefore, many may say in that case they have had more money to buy good solid food. True, and therefore also they have had more money to buy spirits. But why not buy food instead of spirits? For the simple reason they know no better. An increase of money does not bring an increase of wisdom. They found a lot of spirits gave them a lot of strength to do their work,—*ergo*, more spirits would give them more strength. It may be silly reasoning, but it is the reasoning they go through nevertheless. There is also another reason still. They have more money to enable them to forget in debauchery and drunkenness the abandoned filthiness of their homes.

But now we must leave this question for a moment, in order to come back to it when we have looked at the second one brought forward by the Chancellor, as we have now brought it up to that point at which it joins the second, namely :—

"*Some great change in the habits of the people so that they might be induced to abandon the use of such enormous quantities.*"

What wonderful change must this be?

We know we are running contrary to the opinions of many people at the present day when we say that this change must lie in the hands of the authorities, *not* of the people themselves. We have seen in writing, we have heard in conversation affirmations such as the following; in good truth the following itself has been several times advanced to us :—

"A man is born a drunkard; a liar; a thief; an atheist, just as much as he is born, some deformed, some graceful, some quick-sighted, some blind."

Why do such men not carry their assertions onwards and further. Why not say that one man is born a Methodist, one a Baptist, one a Churchman; that one is born a sugar-refiner, one a planter, one a cobbler. And these born of parents who perhaps never knew what a refiner, a planter, a cobbler was. No, the Churchman is baptized into his Church, or else he is no churchman; the refiner is educated to his refinery, else he is no refiner. This Devil's-lie can surely never hold in this world, or else morality and religion are among the things that were, not among the powers that be. No, the drunkard can be kept from being a drunkard, the liar from being a liar, the thief from being a thief, but in order to do this, they must be excluded from other drunkards, liars, and thieves. We do not purify a sovereign after it is a sovereign, we purify the gold in the ore, and then add the necessaries to make it stand the long life it must lead in the world; so we must take the child-drunkard in the ore and purify him by fire if it need be, but purify him and instil into these strengthening forces necessary to make him conquer in the world's fights.

But we *must* begin at home, the chiid must have good food, he must have a clean house, he must know that light and air are as essential to him as they are to the trees and flowers, and we must teach him how to keep them so. We must teach them morality, whether we teach them religion or no, only it is better the two go hand in hand.

It is a strange world that sentence in the Chancellor's speech has opened up. We have now run the two questions in it together, and what do we find? This. That at the bottom of all change in this direction we find education. Not the education we are at present giving our fellow men. Not telling them about things that can be of no practical use to them in this world. But we must educate them in the science of living—in the knowledge of life. We must put down the adulteration of food, we must make the struggle for existence easier and the life happier. But, in the

long run, we have to acknowledge humbly that these words of Tennyson's are no mere sentences of a heated fancy, but the hard imperishable words of truth :—

"Why do we prate of the blessings of Peace? we have made them a curse,
Pickpockets, each hand lusting for all that is not its own;
And lust of gain, in the spirit of Cain, is it better or worse
Than the heart of the citizen hissing in war on his own hearth-stone?

* * * *

And the vitriol madness flashes up in the ruffian's head,
And the filthy by-lane rings to the yell of the trampled wife,
While chalk and alum and plaster are sold to the poor for bread,
And the spirit of murder works in the very means of life."

No! it must be another life than this we must keep near us. It must be a life where no voice is heard of cursing against those who have it in their power to alleviate their distress. Education must come in—in to the very hearths and homes. Not that education taught in the day school and rendered useless in the night school, but the truest, purest education of everlasting knowledge. And then we shall be able to say that we hear upon our shores the happy cry—the *vox populi*,—the people's voice, and that too in wisdom and worth, thanking us for our work :—

"A people's voice! we are a people yet,
Tho' all men else their noble dreams forget,
Confused by brainless mobs and lawless Powers:
Thank Him who isled us here and roughly set
His Saxon in blown seas and stormy showers,
We have a voice with which to pay the debt
Of boundless love and reverence and regret
To those great men who fought and kept it ours.
And keep it ours, O God, from brute control;
O Statesmen, guard us, guard the eye, the soul
Of Europe, keep our noble England whole
And save the one true seed of Freedom sown
Between a people and their ancient throne,
The sober freedom out of which then springs
Our loyal passion for our temperate kings;
For, saving that, ye help to save mankind,
Till public wrong be crumbled into dust,
And drill the raw world for the march of mind,
Till crowds at length be sane and crowns be just."

EXPERIMENTS ON THE CULTIVATION OF SUGAR BEET IN THE CAMPAGNA ROMANA.

By F. Sestini and G. Del Torre.

(*From the Gazzetta Chemica Italiana, iii, 190—195.*)

The experiments were made at Grotta Rossa, near Rome, on a piece of land divided into six equal portions, three of which were manured respectively with superphosphate, common ashes (? wood ashes), and stable manure, while a fourth was left unmanured. In these four plots the seed was sown in March, the fifth being left for transplanting the beets, and the sixth for later sowing.

The following table exhibits the mean weight of the roots, and the richness of the juice of plants gathered on the 1st of August, from the manured and unmanured plots :—

Varieties of Beet.	Average weight of the roots.		Sugar in 100 grams of juice.	
	Plants manured with superphosphate.	Unmanured.	Plants manured with superphosphate.	Unmanured.
	grams.	grams.	grams.	grams.
Vilmorin	706·33	439·00	11·075	10·995
Magdeburg	601·33	416·00	11·695	11·181
Silesian	749·00	411·00	8·023	10·912
Imperial	1339·33	415·00	11·401	8·703
Disette d'Allemagne	848·00	307·66	11·381	13·026

The authors found that, next to superphosphate, ashes are the best manure for beet, on account of the potash salts which they contain. The results of transplanting were not satisfactory, except in the case of the variety called Disette d'Allemagne.

From experiments by Montanaro, cited in the author's original paper, it appears that manuring with castor-oil cake increases the quantity of sugar in the juice by about 1 per cent.

In plants harvested early in September, the weight of the roots was greater, but the proportion of sugar in the juice was rather less, the average proportion in all the varieties being 9·4 per cent. The largest roots were obtained from the plots manured with superphosphate and with stable manure. Roots weighing less than a kilogram yielded a juice richer in sugar than those of greater weight. From this it appears that there is an advantage in thick sowing, for, though the roots will then be smaller, a given weight of them will contain more sugar.

Plants gathered in October exhibited a slight diminution of weight in the roots, and a greater diminution in the proportion of sugar in the juice, a result doubtless due to the previous rains.

Lastly, the authors give a table of the total weight of the roots grown on each plot, reduced to a hectare of surface. The results show that the greatest number of plants is obtained with thick sowing, and the smallest number on the plots manured with superphosphate, the total weight of the roots being, however, nearly the same in the two cases, and the proportion of sugar greatest in the plants which had been thickly sown.

In the following table no account is taken of the yield of the plots bearing transplanted beets, as it was very small :—

Sugar contained in the entire harvest of the beets :

Unmanured	2143 kilos.	
Manured with ashes	—	
,, ,, stable manure....	2567	,,
,, ,, superphosphate ..	2939	,,
,, ,, stable manure. ... (thick sowing)....	2950	,,
	3529	,,

Journal of Chemical Society.

VALUATION OF THE PRODUCE AND LOSS IN A SUGAR MANUFACTORY.

By M. Ed. Riffard.

(From the Journal des Fabricants de Sucre.)

When the various processes in sugar manufacture are carefully observed, one is struck by the numerous causes of loss which are offered, and of which most certainly most of the manufacturers have no idea.

The following paper, the result of careful experiments conducted in several manufactories, has for its principal object that of giving a kind of statistic of the manufacture, and to show at what points the greatest surveillance is necessary.

The losses are of course variable according to the methods employed for the extraction of the sugar. I by no means pretend to generalize these results, but apply them to manufactories working by double carbonatation.

The composition of beet-root delivered to works serve only in a certain degree as a point from which to determine the production and loss. This composition is in general too variable.

However, were these experiments to be followed and repeated, a useful result would be obtained; it is only by multiplicity of experiments that decisive results can be arrived at.

The production and loss experimentally considered in each operation, and of which I proceed to give the details, have reference to the working of 24 million kilogrammes (24,000 tons) of beet-root by double carbonatation.

§ 1. Rasping.—Preparation of the Juice.

1st. *The Juice.* The composition of the juice of beet-roots is very variable; it is dependent upon the quality of the beet-roots in the first place, the amount of water added in rasping and on the mode of pressure.

The juice in question was obtained by hydraulic presses. The average of daily analyses of this juice with and without addition of water in rasping, gives the following figures:—

	Density at 15 deg. C.	Degree Balling.	Sugar per Hecto.	Co-efficient of purity.	Proportionate Value.	Water per cent.	Sugar per Cent.	Foreign Matter per cent.
Juice with Water ..	1,0451	11,16	8k,281	0,742	6,145	89·33	7·92	2·75
Juice without Water ..	1,0505	13,07	9,443	0,722	6,820	87·55	8·99	3·46

The volume of juice taxed by the Excise is: 213,411 hectolitres (4,695,042 gals.), and their result is as follows :—

Density..... 3·9

Amount assessed 1,171,348k of sugar.

Sugar per hecto . 5k48

If we adopt the figure 8k,281, as representing the average quantity of sugar contained in a hectolitre of juice, and multiply that by the number of hectolitres obtained, we shall see that it has exceeded in the juice

1,767,256k,50 of sugar.

According to this figure the richness of the beet-roots would be: 7,363 ; but to this figure must be added the loss of sugar which remains behind in the pulp, remaining after pressure.

2nd. *The Pulp.* The weight of pulp sent from the press-room has been say: 5,083,880k., corresponding to a production of pulp equal to 21·18 per cent. of the beet-roots.

The analyses of this product have been made by a particular method, which I propose to describe at length: the results are exact, and the method is applicable to all sugar products.

From an average of analyses the following number is arrived at as the general composition of the pulp :—

Water = 72

Dry substance = 28

Sugar = 5·10 for 100 of pulp,

which denotes a loss in sugar of :—

259,278 kilogrammes or per cent. of beet : 1k.08.

The two quantities of sugar furnished

On the one part by the analyses of juice ..	7·363
On the other part by the analyses of pulp .	1·080
Being.....	8·443

represent the saccharine richness of beet-root worked.

Such, then, is the first loss of sugar in the manufacture; beyond this inevitable loss of sugar in the pressure-residue from the hydraulic press, it is necessary to mention for remembrance:

The water for washing the rasps, presses, and woollen sacks, which contains also a proportion of sugar, the amount of which I cannot say, having made no experiments on this subject.

§ II. Defecation. Treatment of the Juice.

The treatment of the juice by lime and carbonic acid leaves:

1. The purified juice.
2. The scum or residue from purification.

Let us consider the raw juice coming from the rasper, and let us follow the various phases of the operation.

It contains according to what has been previously shown 8k.281 of sugar per hectolitre and has for density: 1,0451.

After treatment in the defecating and carbonatation copper, the density of the juice should be decidedly lower, from dilution owing to the addition of milk of lime, from water furnished by the condensation of vapour, and that for washing, as also by the fact of the lime purification itself.

Were there no loss in the residue we ought, in recovering the original volume, to obtain the same quantity of sugar; but one knows that it is not thus in manufacture, and that every kind of residue retains always, besides the water, a certain amount of the useful matter in the heart of which it has been formed, and for this there is no economical means of prevention.

The residue which we have to consider in this case is the scum from defecation.

The average of numerous analyses gives—

Water	= 45·58
Dry substance	= 54·42
Sugar = 2·25 for	100·00 of scum.

The weight of scum obtained in the working of the juice was about 8k.50 per 100 kilogrammes of beet-roots, and for the whole 2,040,798k., denoting a loss in sugar of 45·902k.: being 0·19 per cent. of beet-roots.

By trying to account for the amount of sugar carried away from the rasper by the juice, we obtained according to the above experiments taken in the ordinary course of work and extended to a hectolitre of juice, the elements of the following table:

		Sugar per hecto.
	Juice from the rasper	8^{k}·261
Purification	Carbonated juice.....6·669	
	Drainage water from the filter-press 1·400 ..	8·069
	Scum 0·212	——
	Sugar lost in scum	0·212

per hectolitre of juice worked in general manner.

I have not added the juice and the scum from the second carbonatation; the united products are comprised in the following table.

I here annex the table of alcalimetrical experiments, and the determination of the lime in the juice at different times. The determination of the lime can only be done exactly by precipitation as oxalate and conversion into sulphate. The alcalimetrical experiment gave always too high a figure; for there were determined as lime the alcaline salts of potassium, sodium, and ammonia. We are able to judge of this by the following practical experiments on the same juices; moreover special experiments have confirmed me in this, that there is an indication of a simple theory of mutual action between bases and their salts.

Alkalinity of Juice.

	Titrated by SO_3. Alkalis determined as lime, Grammes per litre.	Titrated by Oxalate.
After First Carbonatation....	2·032	1·225
,, Second ,, ...	0·434	0·247
,, Filtration	0·574	0·164
Syrups at 25°	1·960	0·308
Juice from filter-presses.....		2·600

§ Filtration.

Waters from Washing Animal Charcoal.—After decantation the juice is filtered through animal charcoal.

The density of the filtered juice, as well as the amount of sugar present, increases after this operation, and this increase rises from three causes :—

1st. From evaporation of a certain amount of water during the operation.

2nd. From purification by the charcoal.

3rd. From the passage of the juice through the charcoal having already served to filter the syrups at 25°.

This latter reason is the most certain, and exerts the greatest influence upon the action of the juice.

One may easily conceive that the filtration through charcoal, necessary with the actual process of purification, occasions a loss of sugar.

The charcoal retains in its pores a very considerable quantity of sugar, and whatever the pains taken in lixiviation, it will always retain some sugar.

The four first waters from washing the charcoal are so rich that they are sent off for evaporation.

The fifth serves to dissolve the lime, the sugar it contains thus returning into the manufacture.

The sixth water is thrown away.

We have then to occupy ourselves just now only with this latter in order to determine the loss in sugar.

The determinations of sugar in this water have been made with many precautions, by submitting it to a gentle evaporation, without boiling, and upon a considerable amount taken every five minutes throughout the duration of a washing taking 30 minutes, making thus six specimens representing, with great exactitude, the composition of the water and its richness in sugar.

The results of the saccharimetrical determinations are the following :—

	Sugar per Litre. Grammes.
Maximum	18·80
Minimum	17·50
Average.....	18·15

The volume of water added at each washing might be valued at about 27 hectolitres: we have thus a loss of 49 kilos. of sugar by washing the filters.

But we had 322 filters this season, which gives a loss of 15,778 kilos. of sugar, or 0·0656 grammes per 100 kil. of beets.

The charcoal, which is taken from the filters, contains yet a proportion of sugar which I have found to vary between 0·7 and 1 per cent.

The difficulty of obtaining a homogeneous sample does not permit us to add this loss.

§. EVAPORATION.

Water of Condensation.—After filtration the juices are conveyed to the "*triple-effet*" to undergo evaporation and crystalization.

In these two operations there is an evident loss of sugar, which is shown by analysis of the water of condensation.

Taking into account the deficiency of material for measuring the water which comes from divers apparatus, and considering that it is mixed with cold water for condensing, and of which the amount is very variable; I have contented myself with measuring the amount of sugar in these waters, not trying to separate those from the *triple-effet* from those from the apparatus *à cuire* of which the condensed vapours are united and absorbed together.

Here then are the results:

	Sugar per litre. grammes.
Maximum	2·95
Minimum	1·16
Average.....	2·055

The volume of water evaporated is considerable, and it is safe to say that the loss by mechanical carrying over of the vesicles of vapour charged with sugar is also very large. Moreover

divers accidents from which the apparatus is considered to be free at the time of our trials, such as the frothing of the juice and its boiling over would have a decided influence on the amount of sugar in these waters, and by necessity on the loss which results in the manufacture.

It might be admitted without any great error that the volume of water produced by the condensation of the vapours is, at a minimum throughout the manufacture, 5000 hectolitres.

§. MASSE CUITE.

Centrifugals—Production—Molasses—The products which result from the concentration of pure juice are known under the name of "masse cuite."

The gross yields known as the 1st, 2nd, and 3rd crystals have merely a relative interest in this memoir. I will content myself with establishing, according to their production and the average of numerous analyses of sugar, the real total weight of pure sugar obtained; it is 1,143,321k, being 4·7638 per cent. on the beet.

This much also for molasses; its total weight and its richness in sugar, show that it contains 452,793k of sugar, being 1·8866 per cent. on the beet.

On examining all these figures, the following table is obtained:

PRODUCTION AND LOSS.

		Total.	Per cent. of Beet-root.	
Sugar containing	Juice	1,767256k50	 7·3635	
	Pulp	259378	 1·0803	
		2,026534k50		8·4438
Sugar lost.	Pulp	259278	 1·0803	
	Scum ..	45902	 0·1912	
	Filters ..	15778	 0·0656	
	Evaporation	688·43	 0·0028	
	Molasses .	452793	 1·8866	
	Charcoal, &c.	108774·07	 0·4535	
		883213·50	 3·6800	
	Extracted	1,143321	 4·7638	
		2,026534·50		8·4438

About one-half per cent. of sugar lost remains unaccounted for in this synoptical glance. This amount should be put down to inevitable errors in chemical analysis and to numerous manufacturing operations: losses in the press-room, to defecation, in the charcoal, to boiling over, leakage of juice, of syrups in the *triple-effet*, &c.

The other values retain their sad reality and if these figures are not constant and identical for all works, one might without any great error, admit that they differ among themselves merely a few hundredths, more or less.

One understands, of course, that certain conditions of beet-roots, certain peculiarities of work, the employment of methods or of apparatus different from these or newer, careful workmen, active surveillance, intelligence and interest, etc. are the causes of any variation in the signification of these figures and of the advantages to works accruing from that portion of sugar lost to others.

Would it not be interesting for each manufactory to follow the plan I have indicated and that every year, so as to render a true account of the working, appreciating at their just value the different purifying processes and thus attaining to a permanent control of loss and of production.

These labors easy of execution when they are followed, would I am satisfied, and have also proofs, shed forth useful light in the hearts of manufactories, by showing immediately the defective points towards which it is necessary to apply a prompt and logical remedy.

CANE RUST AND OTHER MATTERS.

Your article on Sugar Cultivation and Disease induces me to add a few observations made during the past season on the "rust," or sugar cane disease.

In the first place I would point out that, with the exception of four acres of cane, all the cane at St. Helena was more or less attacked by the rust. The Bourbon was the first to show the disease. The damage to this variety was so serious that a very

large portion was not worth the crushing. All the other varieties were slightly touched. The four acres not attacked were ribbon cane, and the piece is in the lowest part of the island. The soil is of much the same quality as the other parts; but about two feet under the surface of the soil there is salt or brackish water to be found. Now it is my belief that the salt in this four-acre block saved it from being attacked with the rust.

It is a well-known fact that salt has been used in Scotland for many years for rust in wheat and other crops—and used with success too.

There is not the least doubt that rust and similar diseases are caused by the want of some of the essential food required to nurture plants, and I am of the opinion that if salt were more generally used on the Darling Downs, we would not hear so much about the rust; and if it was supplied to horses, cattle, and sheep, we would not see so many unshapely, hide-bound crawlers in the colonies.

I quite agree with you that drainage is very much required in many, in fact nearly all cultivated lands, to give a more equal temperature to the soil. I am not at all surprised at disease attacking the bananas, for to my knowledge the banana has been grown on the Brisbane River for the last thirteen years in the same soil, and very generally without cultivation. I would like to know what would farmers in the old country say if you informed them that the soil of Queensland had grown the same crop without cultivation for so many years. I think all seeds and plants should be changed from one soil to another. I do not think that cane that has grown for a few years on a plantation should be used too often in the same soil.

As to the use of lime in agriculture, there ought to be no such difference of opinion among practical men regarding the use of lime or similar kinds of manure, seeing that the laws that regulate their action are fixed and constant, and will always tend to produce the same effect whenever and wherever they are applied. When, therefore, we find men giving contradictory and disappointing accounts of the results of their experiments, the explana-

tion is to be found in an ignorance of the composition of their soils having led them to apply lime where it was not required, and not to the lack or virtue of the lime itself, or uncertainty or caprice in its action. Take the case of three plantations or farms: The first, we will suppose, has gneiss-rock subsoil, a geological formation that contains scarcely a trace of lime; that of the second, from the decay of the trap or greenstone rock, which contains sometimes as much as 5 per cent. of lime; and that of the third, from the decay of the chalk or limestone rocks. Now we could scarcely expect the same results to follow the application of lime to each of these supposed soils. The first would be much improved by a judicious liming; on the second we would expect to produce less apparent results; whilst on the third the application of lime would be positively injurious; and should the farmers not possess the necessary chemical knowledge to ascertain the composition of their soils, we would have one farmer praising the use of lime, another condemning it, a third asserting it produced little effect of any kind.

That lime, as distinguished from guano, was the preparer of the soil, while the latter went to feed the plants, is a belief calculated to mislead. Bearing in mind that all genuine guanos contain a variable, but always very considerable, percentage of carbonates and phosphates of lime, it must be quite clear that, in at least to the extent in which the two substances agree in composition, to the same extent must they agree in their effects either on the soil or plants.

I am quite aware that some of the many beneficial effects resulting from intelligent and proper use of lime are produced upon the soil, such as, when applied in the caustic state, its combining with the acids which result from the natural decay of vegetable matter, thus removing the sourness and preventing the accumulation of noxious gases in the soil, or the important use of lime on stiff clay soils in liberating, for the use of plants, the valuable alkalies of potash and soda from their combination with the alumina, or clay, and the good results that follow the application of caustic lime on pasture lands where the natural grasses year after year are fast

giving place to useless weeds on many of the stations throughout the colonies. In fact, lime is used with good results on all soils containing an excess of vegetable or organic matter, by its hastening the decay of such matter, and thus restoring the vegetable and mineral elements in the soil to the relative proportions necessary for the healthy growth of plants. All this, and much more of a similar nature, I am quite aware lime will do; but of its use in agriculture, let me ask, How do the animals fed on either farm produce or natural grasses derive the nearly sixty per cent. of the phosphates and carbonates of lime of which their bones are built up—not to speak of smaller percentages contained in other parts of the animals—viz., in the blood, muscle, fibrine? I answer, they obtain these substances from the plants on which they feed, and that these, in return, derive their supply from the soil in which they grow.

The truth is, it is only on certain soils, and under certain circumstances, that lime is required as a mechanical ameliorator of the soil; but on all soils, and under all circumstances, it is necessary as a chemical constituent of plant food, there being no mineral substance that enters so largely and so generally into the composition of most of the cultivated plants. Chemical analyses have proved that in every ton of lucerne there are 110lbs of lime. I do not know how much lime would be in a ton of sugar cane, but I am sure there is a large percentage.

Now, although the amount of lime absorbed by plants may appear relatively small, it must be remembered that it is just as essential to their healthy and perfect developement as the much larger amount of carbon and water that form their bulk. Indeed, such crops as peas and clover won't thrive at all on land that does not contain a very considerable percentage of lime. Nor must it be supposed, as I suspect is too often done, that some mysterious kind of chemistry goes on in the interior of plants and animals, by which they are able to transform whatever substance they may happen to absorb into the elements required for the building up of their bodies. There never was a greater delusion.

If plants do not find all the mineral ingredients necessary for their healthy growth in the soil, they will never either have them in their composition, or grow to perfection; and similarly, if young

animals do not obtain lime, pure and simple, in their food, their bones will never increase a pound in weight. In proof of this, let any one shut up a few hens or ducks, and continue to feed them on food containing little or no lime, such as potatoes, or the grain of wheat, and I will be surprised if, by-and-by, their eggs do not cease to have shells upon them, and if, ultimately, the animals do not pine and die from lack of a supply of bone material.

In conclusion, I think it cannot be expected that the soil of Queensland will go on yielding crop after crop of the same kind without breaking up, and returning to the soil a little of the ingredients taken out by each crop.

I hope some of your numerous readers, both North and South, will give their own observations on this rust or cane disease. It does not cost very much to try what salt will do; and I intend to put it to the test on some cane that was very much attacked last season.

JOHN M'DONALD.

Government Plantation, St. Helena, January 10, 1874.

CANE RUST.

Reading your papers on cane and cane rust for the last two or three weeks, I have been much struck by the difference between my ideas concerning cane rust, and those in the articles. I have had as much experience of cane here as most Queensland growers, and I have found that rust invariably comes in the best drained land where there is an absence of clay. Where dark or gray clays are the subsoil, rust appears to me to be invariably absent, though the cane ten yards off may be destroyed with it where the clay is absent as a subsoil. As everything tending to a knowledge on cane matters cannot be too widely spread, I hope some of your numerous readers will be able to corroborate what I say, or explain it, so that a discussion may be raised among cane growers about rust, on the best land to choose to be free from it, as well as the cure. I speak of Bourbon cane and the Chigacca, the only ones I have seen with rust here.

J. P. S. PINWILL.

Koorooroo, January 12.

CANE RUST.

Mr. Pinwill is quite right in saying that the "rust invariably comes in the best drained lands;" and, like Mr. Pinwill, I would like to have the matter explained. I notice that in our deep, rich scrub soil we can grow the common Ribbon, Yellow, Djongdjong, Malibar, and a few other varieties without a speck of rust, whilst the Chigacca, Bourbon, and Salangore, would be seriously affected.

I have about two acres of Chigacca (one acre second ratoons) growing on a good surface with a clay subsoil, especially free from rust, and a most satisfactory cane it is on such soil. With a view of helping towards an explanation, I will mention a little matter that came under my own notice some time ago. Being informed that a neighbour's cane (Chigacca) had got the rust, I went to see it. It was a splendid one-year old crop, growing on deep scrub soil. I could detect the rust around the outside of the field, but the owner informed me that there was a very bad patch in the centre. We went in to see it, and sure enough it was bad; no change of soil; but a little conversation brought out the fact that a few years ago that patch of ground had been occupied by a pig-yard. I quite agree with Mr. M'Donald in reference to the application of salt, but in connection with sugar cane I think it should be used sparingly.

In conclusion, I would remark that I don't feel the least uneasy about the cane rust; I find that we have varieties of cane seemingly suited to the different classes of soil (a very good thing too); and as our knowledge in cane growing increases, I am in hopes that we will be enabled to dismiss the cane rust by the adaptation of the different varieties to the soil that suits them best.

Alex. Watt.

Indooroopilly, January 29.

From the "Queenslander."

ON THE RESPIRATION OF BEET-ROOT AND THE AIR INCLOSED IN IT.

By A. Heintz.

Ingenhouss observed as early as 1779, that roots, flowers, and fruit continually give off carbon dioxide. To study this slow combustion, the author selected beet-root, which he kept for 30 days under a bell-jar, at a constant temperature of 10°.

	Grams.
Weight of root before the experiment	4400
Oxygen taken up	25·2
	4425·2
Weight after experiment	4330·5
CO_2 formed	34·3
H_2O ,, ...	60·4
	4425·2

This shows that the cane-sugar is oxidised according to the equation :—

$$C_{12}H_{22}O_{11} + 12O_2 = 11H_2O + 12CO_2.$$

The quantity of oxygen calculated from the carbon dioxide being 24·9, while 25·2 were found.

According to these results, 1,000 cwt. of beet-root would lose 10 cwt. of sugar in two months.

To examine the gases contained in the root it was ground down to a pulp and heated with a little water to 100° for two hours.

In one experiment the composition was found to be in volumes $CO_2 = 30{\cdot}52$, $O = 0{\cdot}14$, $N = 69{\cdot}34$, and in another $CO_2 = 35\ 10$, $O = 0{\cdot}56$, $N = 64{\cdot}31$.

1,000 grams of root gave 130—150 c.c. of gas.

As by the action of heat more carbon dioxide was probably formed than was originally contained in the root, the juice was quickly pressed out and exhausted with Sprengel's air-pump. The experiment lasted five hours and the gases were collected in three portions :—

	(1.)	(2.)	(3.)
CO_2	11·49	41·02	78·90
O	1·53	2·10	0·06
N	86·98	56·88	21·04

Journal of the Chemical Society.

WILL CANE-GROWING PAY IN THE SOUTHERN DISTRICTS?

Within the last month I have had occasion to see a good many plantations in these districts; and what I have seen convinces me that this question, which is often asked, can only be answered by making a marked distinction between the cane planter and the cane farmer. I have had a good experience in the growing and manufacture of cane in Queensland, and can say—and time will prove how truly—that cane-farming will pay, but that cane-planting would ruin a bank—let alone men with a moderate capital.

The cane planters (the many) get in the plants, and there their work ends—or at least the fields look so, being a compact mass of weeds and grass, with a few stunted canes here and there. All attempts at ploughing—or anything but scratching—are ignored; whereas deep cultivation is what the cane especially requires and responds to. But the cane planter does not see with that light yet.

Sometimes in new and rich land, and with a good season, they do get a heavy crop, weed-seeds being scarce; and then of course they don't forget to "blow" off what they have done at small expense, when really it only happens by mere luck. When their land gets full of weed seeds, then the crops get less and less, and the profits become *nil*. Any business conducted in such a slipshod manner, be it farming or mercantile business, must come to grief in the end.

I have just seen plantations which, as a farmer of cane, I cannot but consider reduced fully half in value by the necessary amount

of labour which even a good farmer would have to employ to clean the land from the weeds on the fields, and the weeds to come from former generations of weeds which have seeded. Anyone who knows the difficulty of getting back neglected land to a reasonably clean state would fight shy of purchasing such places, except at a very low figure. To me it is a question whether it would not be better to tackle new land and clear it.

The cane farmers (the few) appear to have their places in a reasonably good state of cultivation. Weeds are few, and are well in hand, and where the cultivation was deepest the cane seemed best and less hand labour was necessary, the work being mostly done with horses. To do this work at best time to save labour, by tackling the weeds when young, is the motto of the farmer, and the farms prove them right. Moreover, they seemed satisfied with their prospects for the future. It seems to me a simple matter of judgment. The man with good judgment for his particular work does best in cane-growing or any other business. I myself can see cane three years old in rich scrub land much smaller than cane four months old with good cultivation. But the cane planters seem as if they would not learn, even if by going a few hundred yards they can see what the farmers of cane are doing. I say that the sooner these cane planters finish their money and leave, the better it is for that district and themselves. I know that the Logan and Albert district, with some of the finest and most lasting land in the colonies, has been much reduced for cane-growing simply from the superabundance of cane planters, and the small number of cane farmers who know their business and do it. Mr. Caldwell, who was here from the Mauritius, said it was equal to the best land he had seen for cane anywhere, and said not to mind a little frost, for they had the land for cane.

At present scrub land seems to be most thought of, but I am still of opinion (and I know several good farmers who coincide with me) that much of the forest land will in the long run be considered the best, from the greater abundance of mineral food the cane can obtain from the soil, the invariably higher density of the juice, and from the less liability there is to disease and borer in the cane.

The Government statistics of the return of sugar from a district are very liable to deceive those not behind the scenes, especially where cane planters are numerous, and cane farmers few. Their poor returns bring the good ones down to a low average.

In the manufacture of sugar, too, there seems to be a great deal too much guess work and rule-of-thumb business in the clarification of the juice. In very few mills are even the commonest and cheapest tests, such as litmus paper, &c., ever used, or even kept for use; consequently, to find a man who has anything but the merest smattering of knowledge is unusual. On some of the places, too, where they have the tests, after giving them a half trial they are thrown on one side as useless, because there is no one who has sufficient knowledge or judgment to tell where they were wrong. By simple tests, properly handled, juice never need be badly clarified.

In the re-boiling of molasses, also, there seems to be no attempt at re-clarification, which is a simple matter with the use of tests, but almost impossible without their aid. As done at most of the mills, it is a mere matter of chance what quantity or quality of sugar is got out of second or third boilings. The great fault appears to me to be liming too heavily in the juice, which has to stand a high heat, and not putting enough in the molasses, which is boiled in a low temperature pan. Molasses from properly clarified juice will, I believe, always be found to be acid, and often strongly so, though there was no sign of acid before the sugar was dried, even by test-paper.

There might be great improvements made, too, in the filtering and subsidence of juice. Blanket filters are rare, and where subsiders are used between the battery and low temperature pan, no attempt is made either at the correction of the clarification, or the use of any fining agents. One of the managers of the larger mills laughed at me when, in answer to his growling about bad clarification, I mildly suggested correcting it in the subsiders. He said he had tried it, and it was impossible; so I said no more, but thought he appeared to me to be a man who was undertaking work he knew little or nothing about.

I think it is a great mistake of the Government not to allow the

making of methylated spirit on all plantations free. The skimmings, washings, &c., are absolutely thrown away, and the molasses given away to the distilleries for half its value, or started on the manure heap. Now nothing will persuade me that that sort of sheer waste can be right, in spite of the opinion of all the Inspectors of Distilleries under the sun. What I should like to see would be methylated spirit stills free, with very heavy penalties for making consumable spirits, or otherwise breaking conditions. As it is, the Government are simply oppressing the cane interest in a way not done elsewhere, and to an amount which, in a new industry, is an especially serious matter. In the West Indies the spirit made pays most of the expenses of the plantation labour; and so it should do here, where it would often make the difference of profit and loss on a season's crop.

The Bonded Sugar House Bill of last Parliament was a scheme to weigh down the whole body of sugar growers for the benefit of one firm of sugar refiners. It showed us that some of our members were very remiss to let such a shameful Act pass. I hope one of the first acts of the new Ministry and Parliament will be the repeal of that short-sighted Act, and the allowing of methylated spirit stills free; and then they will be doing only fair justice to a rising industry, and putting Queensland sugar-growers in a position to compete with the same industry in other parts of the world.

P. X. N.

From the "Queenslander."

YIELD OF JUICE AND SUGAR.

Whilst reading an account of a discussion at the Institution of Civil Engineers, on the Aba-el-wakf Sugar Factory, Upper Egypt, I noticed a remark made by Dr. Henry Letheby with reference to the percentage of juice obtained from the cane, which will, I think, interest some of your readers; and accounts for the superior sugar our horse-mills often make compared with sugar from heavy steam plants. He says:—"Turning, however, to one of the principal

subjects of discussion—namely, the action of the rollers and crushing machinery, it was a very important question whether it was really desirable to get all the juice possible out of the sugar cane; for it was a well-known fact that the juice first squeezed out, coming as it did from the loose cellular tissues, was much richer in sugar, and less charged with albumen and saline matter, than that which flowed from the harder tissues. In the olden time there was less difficulty in crystallizing sugar, and *larger products* from a given volume of juice were obtained than now, when so much greater pressure was applied, and when the yield of juice was, perhaps, almost doubled. He did not know the yield of the Egyptian canes, but formerly, in the West Indies, when not more than 50 per cent. of juice was obtained, sugar was made at a profit. Now, on an average, from 75 to 80 per cent. of juice was obtained; but that juice was so charged with nitrogenous and saline matters coming from the harder tissues of the cane, that he doubted whether it did not interfere very considerably with the profitable working of the sugar afterwards, and it was a question whether there would not be an advantage in separating the two juices from each other; for, ordinarily, they had a little less than two parts of saline matter in one thousand, and the same proportion of nitrogenous matter in the juice which flowed from the soft tissues; but, by higher pressure, sometimes nearly double that quantity of these objectionable impurities was extracted. It was evidently, therefore, an important point for consideration, whether it would not be profitable to separate the juice of the first pressure from that of the second, seeing that in the first case a much better sugar was obtained than in the second."

COOMERA.

From the "Queenslander."

ON THE SILESIAN BEET.*

A Company has recently been established in Dublin for the purpose of introducing the manufacture of beet sugar into Ireland. It has secured a large farm at Bodenstown, county of Kildare,

* From a pamphlet "On the Culture of the Silesian Beet." By Dr. C. A. Cameron. Dublin, 1874.

whereon it proposes to grow beets and manufacture beet sugar. It also proposes to purchase beets from the neighbouring farmers, for which it offers £1 per ton. As it is important that only the varieties of beet richest in sugar should be grown, the company decided to make some experiments with the view of ascertaining the kind which it could cultivate with most advantage, and which it could recommend to be grown by the farmer. Accordingly, ten kinds of seed were sown in the demesne farm of Mr. Hamilton, at Abbotstown, county of Dublin, which were kindly placed at its disposal by that gentlemen. The land in which the beet was grown is a rather stiff clay, and at the time of sowing it was almost impossible to get a fine tilth, owing to the drought which then prevailed. The consequence was that the seed germinated very unevenly, the young plants in some instances not coming up for several weeks. The crops were manured with thirty tons of dung, some bone superphosphate, and two cwts. of kainit (crude potash compounds) per statute acre; the land was well limed. I think that the amount of farm-yard manure applied to the crops was excessive, and with less manure the result would have been more satisfactory. The results of this experiment are given in the following table:—

Sugar Beets grown at Abbotstown, Co. Dublin, sown 2nd of May, lifted 5th of November, 1873.

Numbers.	Name of the Varieties.	Cultivated surface in square feet	Weight of Produce in Pounds.	Produce per Statute Acre.		
				Tons.	Cwts	Qrs.
1	White, green-necked	610	784	24	19	1
2	„ rose-necked	„	728	23	3	2
3	„ grey-necked	„	644	20	10	1
4	German, green-necked..	„	756	23	18	3
5	„ acclimatized in France ..	„	644	20	10	0
6	Imperial (true Knauer)	„	560	17	6	3
7	„ acclimatized in France ..	„	896	28	11	1
8	Electoral (true Knauer)	„	700	22	6	1
9	„ acclimatized in France ..	„	728	23	3	3
10	Improved Vilmorin	„	644	20	10	1
	Totals	6,100	7,084	225	0	0
	Averages	610	708	22	10	0

Some of the roots grown in each plot were submitted to me for analysis, and the following were the results obtained: —

Composition of Sugar Beets, grown at Abbotstown, Co. Dublin, 1873. 100 parts of each kind contain:—

No.	Names of Varieties.	Water.	Albuminous substances.	Sugar.	Pectose, fibre, &c.	Mineral matter (ash.)	Total.	Produce of Sugar per Statute Acre, deducting one-fifth from the weight of the crop for unsuitable roots, &c. Tons. Cwts. Lbs.
1	White, green-necked	84·24	1·62	6·80	6·15	1·09	100	1 7 20
2	White, red-necked	84·66	1·40	7·25	5·71	0·98	100	1 6 100
3	White, grey-necked	83·67	1·30	10·14	3·24	1·55	100	1 13 34
4	German, green-neck	82·02	1·20	9·20	6·33	1·25	100	1 15 26
5	,, acclimatized in France	82·18	1·13	4·65	11·10	0·94	100	0 15 29
6	Imperial (true Knauer)	83·68	1·32	8·50	5·40	1·10	100	1 4 30
7	,, acclimatized in France	79·72	1·88	11·11	5·92	1·37	100	2 10 94
8	Electoral (true Knauer)	80·84	2·04	12·40	3·74	0·88	100	2 4 30
9	,, acclimatized in France	84·15	1·25	9·18	3·79	1·63	100	1 14 6
10	Improved Vilmorin	79·00	1·57	12·66	5·63	1·20	100	2 1 44
	Average	82·416	15·69	9·209	5·701	1·209		1 13 30

The analysis of each kind of beet represents the average composition of three roots; the average weight of each kind was as follows:—

Average Weight of Roots.

1	2	3	4	5	6	7	8	9	10
1½ lb.	1½ lb.	1 lb. 6 oz.	1 lb.	1¼ lb.	1½ lb.	1¼ lb.	1⅓ lb.	1¼ lb.	1¼ lb.

These results are very satisfactory. If the three best kinds of beets (Nos. 7, 8, and 10), as shown by these experiments, be grown, the yield of sugar (for manufacturing purposes) will be from 2 tons 1 cwt. 44 lbs. to 2 tons 10 cwts. and 109 lbs. of sugar per acre.

The Rev. Professor Jellett has determined the amount of sugar in Irish grown beets by means of his new saccharometer, and found the proportion to vary from 11·02 to 12·59 per cent.

ON CANE SOILS.

We have taken the following article from a work on "Sugar Agriculture," by Dr. T. L. Phipson, reviewed in our pages last year; we give it as an important part of an *important* little book:

"In order to appreciate the actual state of the cane soils in our West Indian Colonies we cannot do better than consider, in the first instance, the composition of two soils (chosen with care from a considerable number that have been analysed by me within the last few years), representing *a new soil* and *an old soil*. The first, A, is from an estate in Jamaica now under canes for the first time; the other, B, is from a plantation in Demerara, which has been worked more than *fifteen* years consecutively. It is not difficult to see how valuable a lesson is to be learnt from these two analyses alone, but some others are given further on.

Let me simply add that to the eye of the most experienced planter or chemist there was scarcely any appreciable difference in the aspect of these two soils; the sample A was merely a clay of rather darker colour than B, but nothing in their external appearance could have indicated the widely different composition which they gave on being carefully analysed:—

Types of Cane Soils.

	A.	B.
Moisture	12·25	18·72
Organic matter and combined water.	15·36	6·03
Silica and insoluble silicates ..	48·45	68·89
Alumina	13·80	2·50
Oxide of iron	6·72	2·60
Lime	0·99	0·08
Magnesia	0·29	0·25
Potash	0·11	0·10
Soda	0·70	0·09
Phosphoric acid	0·10	0·03
Sulphuric acid	0·30	0·03
Chlorine*	0·51	trace.
Oxide of manganese, carbonic acid, and loss in analysis	0·42	0·68
	100·00	100·00
Nitrogen (in organic matter ..	0·31	0·05

To persons accustomed to discuss analyses of soils nothing can be easier than to see that in A we have everything that is requisite to grow canes for a considerable number of years, whilst B is a soil fast approaching to exhaustion. I will merely call attention here to the greater amount of *organic matter* (humus), *nitrogen*, *lime*, and *phosphoric acid* in A, and to the important fact that in B the quantity of lime, 0·08, is far below that of the magnesia, 0·25. This I have ascertained to be a very bad sign in cane soils,

* The quantity of chlorine is unusually high, which is accounted for by the proximity of a salt spring. Such springs are by no means uncommon in the island.

and it will probably be found to be so in soils devoted to the cultivation of almost any other plant.

It appears, indeed, from the results of a numerous series of analyses carried on in my laboratory for some years past, that *the degree of exhaustion which a cane soil has undergone can to a great extent be ascertained* by comparing the relative amounts of *lime* and *magnesia* yielded to analysis. Here are four examples from the *same estate* in British Guiana, from *various portions* of which the samples were taken :—

	Cultivated.			
	10 to 15 years.		Upwards of 60 years.	
Lime (per cent.) ..	0·44	0·64	0·11	0·40
Magensia ..	0·32	0·50	0·36	0·51

I might, perhaps, have found still more striking examples, but these will suffice to show how the *lime* has disappeared (from the *same soil*) by prolonged cultivation of the cane, whilst the *magnesia* has remained pretty much as it was.

In coffee soils from Ceylon I have found much the same thing occurs also, but that the magnesia is more taken than with the cane. This is natural enough, since it forms an important ingredient among the mineral matters of the seed of the coffee-plant, which seed is carried away from the soil after each crop. However, even in coffee soils the magnesia diminishes less rapidly by cultivation than the lime. It is quite possible in some cases to judge very approximately of the number of years a soil has been in canes by the inspection of a careful analysis of this soil, more especially when the analysis can be compared with one made of the same soil from some uncultivated spot on the borders of the plantation.

When the quantity of lime has diminished so much by prolonged culture as to be present to the extent of only 0·1 *per cent., and then only one-third that of the magnesia present (knowing that in the origin the lime was not only equal to, but higher than, the magnesia), we may rest assured that the crops of cane on this soil will fall off year by*

year, and that the most careful system of manuring will be necessary to place it again in its former lucrative condition.

I am sorry to say that such a state of things actually exists over a very considerable portion of British Guiana and Barbadoes; and though Jamaica and the other islands appear somewhat more fortunate in this respect, yet we have here and there examples of long-wrought soils which are quite in as bad a condition as the most exhausted plantations in Demerara.

It is both difficult and laborious to choose from a very considerable number of analyses of cane soils those which may be considered to represent the actual state of things in the West Indies. I have nevertheless given, on the adjoining page, a few which represent some very extensive plantations, the owners of which have kindly permitted me to publish them. These, with the few remarks appended to them, will enable me to pass on to another important portion of our subject.

It is commonly held that soils in hot countries, especially in tropical climates, contain more organic matter than those of our latitudes; but it is evident from the above analyses that such is not the case for cane soils. The figure which includes organic matter and combined water owes a great deal to the latter, which is driven off by heat with the organic matter. In fact, putting aside soils of a peaty nature, it is rare that we meet with cane soils yielding more than from 2 to 4 per cent. of *humus* or "vegetable mould;" and the loss of this organic matter has been proved a source of sterility in Java by causing a want of porosity, of nitrogen, and of carbonic acid. Hence the danger of applying lime to these soils, much as most of them require it, since it tends to destroy the *humus* in a very short space of time. In our own climates lime is always "backed up," if I may use the expression by a liberal supply of organic manure; and this is even more essential in Demerara than with us.

Analysis of Cane Soils.

	Demerara.							Barbadoes.		Queensland.	
	A	B	C	D	E	F	G	H	I	J	K
Moisture	26·00	23·00	26·70	14·12	25·00	13·88	22·64	16·00	19·00	13·00	23·10
Organic matter and combined water	5·90	5·30	8·30	6·17	8·86	32·39	7·06	7·88	9·11	10·50	12·56
Silicate of alumina and silica..	61·68	64·44	58·02	68·08	57·49	46·50	68·00	68·22	65·00	60·00	41·42
Lime	0·64	0·11	0·47	0·17	0·28	0·48	0·45	0·22	0·25	0·30	0·56
Magnesia	0·50	0·36	0·50	0·37	0·36	0·30	0·31	0·30	0·30	0·47	0·26
Sulphuric acid	0·01	trace	0·01	0·16	0·04	0·04	0·20	0·12	0·03	0·03	0·04
Phosphoric acid	0·08	0·05	0·19	0·07	0·09	0·03	0·16	0·10	0·07	0·06	0·06
Potash and soda	0·11	0·10	0·12	0·54	0·26	0·24	0·30	0·10	0·10	0·16	0·20
Chlorine	trace	0·02	0·01	—	0·01	0·06	0·05	trace	trace	trace	0·02
Oxide of iron, alumina, manganese, &c.	5·08	6·62	5·68	10·32	7·61	6·08	0·83	7·06	6·14	15·48	21·78
	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00

Observations.—A, B, and C are soils in adjacent plantations of the same estate. A has been in canes about five years; C for a somewhat longer period—10 to 15 years; and B for about 60 years. D and E are from adjacent estates, far distant from the former; they have been in canes 20 to 25 years. F is a new soil, now growing ferns only. It is about to be planted with canes as an experiment. This soil, when it has been dried, burns like peat. G and H are from plantations only separated 100 feet from each other by a canal. G is a new soil; H has been in canes about 15 years. I and J are good average specimens of Barbadoes soils, and K is a sample of red clay soil from Queensland, Australia.

INFLUENCE OF BEET ROOT SUGAR CULTURE ON THE FERTILITY OF THE SOIL.

When the beet is grown for the purpose of feeding cattle on the farm, the substance which it takes from the soil will be returned to the latter in the form of manure, *minus* the amount carried away in the carcasses of the animals sold off the farm. Under these circumstances, the influence which the beet exercises upon the soil differs but little from that produced by other root crops. But when the beet is sold to the sugar manufacturer, a large amount of phosphates, and a still larger quantity of potash, are taken altogether away from the farm. The question, therefore, naturally arises—How is the fertilising matter withdrawn from the farm by the beet sold to the sugar manufacturer to be restored to it? It is not difficult to reply satisfactorily to this question. Sugar, as I have already stated, is composed merely of carbon and the elements of water; it does not contain nitrogen, phosphates, or potash—the three manurial agents which are of any value. The beet as a whole contains nitrogenous matters, phosphates, and potash, but these ingredients are not what the sugar maker wants; and when he separates them from the sugar they constitute incidental or bye-products—namely, pulp and molasses. The pulp is too bulky an article to admit of its being transported to a distance greater than that from which the beets are brought to the factory; consequently, the natural destination of the pulp is the farm on which the beets that produced it are grown. On the Continent the farmer brings his beet roots to the factory, and he returns home with beet pulp. As the pulp contains nearly all the nitrogen and a large proportion of the mineral matter originally present in the beet, it is evident that if it be returned to the farm, the fertility of the latter will be fully maintained. The molasses produced at the sugar factory contains a large proportion of the potash originally present in the beet; if it be also consumed on the farm, then everything which is of manurial value goes back to the soil.

If the waste products of the beet sugar factory be consumed on the farm that supply the roots—and that it is the natural and usual

course of events—the farms certainly cannot decrease in fertility. The amount of plant food in the soil is practically inexhaustible; but only a very small proportion of it exists in an immediately available condition. Tillage adds to the stock of effective nutritive matter in the soil, and tillage is therefore, to a great extent, a substitute for manure. Messrs. Lawes and Gilbert have been growing grain crops every year in the same field for more than a quarter of a century without any manure, and the crops show no sign of a diminished yield. Every year's tillage sets free from the stony fortresses of the soil adequate supplies of phosphates, potash, and other food of plants. In growing the beet the mechanical operations to which the soil is subjected adds to its stores of effective fertilizing matters. Of these a portion is removed in the beet crop, but it is returned to it again from the factory as pulp, either directly, or indirectly in the form of animal manure. The foliage produced by the beet is also a valuable source of manure. The farmer who sells milk, cheese, meat, and grain, and especially potatoes, sends off his land a greater amount of phosphates and nitrogen than he usually applies to it in the form of manure. It is clear, then, that a beet sugar factory must necessarily increase the fertility of the district in which it is situated; because it keeps in the farms on which it depends for roots the phosphates, potash, and nitrogen—substances which ordinary crops remove in great part from the soil.—*From a Pamphlet "On the Silesian Beet," by Dr. Cameron.*

ON THE PRESENCE OF ARABIC ACID IN THE SUGAR BEET, AND ON ARABIN SUGAR.

BY C. SCHEIBLER.

(Deut. Chem. Ges. Ber., vi. 612-622.)

The author describes the further examination of a constituent of the cellular tissue of the sugar-beet, which, under certain circumstances, passes over into the juice and then most seriously hinders the extraction of crystalline sugar, to which he first drew

attention now five years ago (*Deut. Chem. Ges. Ber.*, i. 58 and 108). This substance was originally examined by Fremy, who, on account of its supposed identity with an acid obtained from pectin, termed it metapectic acid. Its complete investigation has been much delayed, on the one hand by the circumstance that it is not always obtainable in sufficient quantity from the beet, the harvest of 1868-69 having furnished scarcely any, whereas that of 1872-73 yielded a large quantity; on the other, by the extreme difficulty of rendering it pure. A number of analyses of products obtained from beet grown in various years, when allowance is made for the ash left on combustion, give concordant numbers which lead to the formula, $C_{12}H_{22}O_{11}$. This formula, however, is the same as that assigned to arabin or arabic acid (from gum arabic); and a comparison of the properties of the two substances shows that they are in all probability identical, which is rendered certain by the fact that when acted upon by dilute sulphuric acid, each yields a sugar, $C_6 H_{12} O_6$, that obtained from the so-called meta-pectic acid exhibiting precisely the same crystalline form, optical rotatory power, and other properties, as that obtained from arabin. This sugar, on account of its formation from arabin, the author terms *arabinose;* it crystallises in well-formed rhombic prisms (measurements of the angles by Prof. Groth are given); the rotatory power of the freshly-prepared solution is $[a] = +121$, which becomes $+116$ after the solution has been prepared for some time, and after warming; arabinose is not fermentable. It is probable that under normal conditions arabin is present in ripe healthy beet, either entirely or in great part in the insoluble state, as so-called *metarabic acid* (*metarabin*).

In his first communication the author stated that sugar-beet arabin was strongly lævorotatory $[a] = -98{\cdot}5$. According to Béchamp gum arabic is also lævorotatory $[a] = -36$. The first sample examined by the author proved to be dextrorotatory, which led him to examine other samples procured from a trustworthy source; and he found that the rotatory power varied from sample to sample, some being more or less lævorotatory, others more or less dextrorotatory; the amount of crystalline sugar furnished by

different samples on inversion also differed. Moreover, both sugar-beet arabin and gum arabic always gave, together with arabinose, a certain quantity of a non-crystalline, apparently fermentable sugar, of which considerably less was obtained from the former than from the latter, a fact which is in evident relation to the circumstance that sugar-beet arabin has a more pronounced lævorotatory action than any of the lævorotatory samples of gum arabic examined. Hence it appears that whilst sugar-beet arabin consists of a powerfully lævorotatory substance (which is usually the main constituent), yielding arabinose, and a second closely allied substance which yields a non-crystalline sugar on inversion—gum arabic, as a rule, contains proportionately more of the latter and less of the former constituent. This view is strengthened, and the analogy between the arabins from the two sources rendered still closer, by the fact that, in preparing arabin from beet from various sources during the past season, the author has observed that in a few cases the product had a slight dextrorotatory action.

The method which the author employs in extracting arabin from sugar-beet is as follows:—The fresh pulp is freed as much as possible from the juice by pressure; the pressed cake is broken up and macerated for several hours with alcohol of 86—90 per cent. Tralles; the alcohol is then poured off, and that which is absorbed removed by pressing, and the pressed cake again submitted to similar treatment. By this means the cane-sugar and most of the non-saccharine substances are removed without the metarabin of the cellular tissue being rendered soluble. The pressed mass is now introduced into boiling water, and heated for some time; pure milk of lime is then added until the solution is strongly alkaline, and the whole is warmed on the water-bath. The metarabin is thus rendered soluble. The solution containing the calcium derivative of arabin is then separated and treated with carbonic anhydride to remove the excess of lime, filtered, concentrated to a small volume on the water-bath, again filtered, rendered strongly acid by the addition of acetic acid, and mixed with a large excess of alcohol; the impure gum is thus precipitated as a gelatinous ropy mass. After some time the alcohol is poured off,

the gum dissolved in a small quantity of water and reprecipitated by alcohol, this treatment being then several times repeated. After a time the arabin is precipitated in flocculi, but however often the dissolution and reprecipitation be repeated, it is impossible to obtain the arabin free from ash constituents.

In conclusion, the author describes a gum different from the above, produced in the fermentation of beet-juice. The juice, when left to itself, assumes after a time a gummy consistency, but on further standing again becomes liquid, and enters into more or less rapid fermentation; the gas at first evolved contains about 15 per cent. of hydrogen, but finally carbonic anhydride alone is evolved. At the conclusion of the fermentation, the solution contains a gum which may be precipitated by alcohol, manite, a liquid sugar, lactic acid, &c. The gum, which is dextrorotatory, has the same composition as arabin, but on inversion by dilute sulphuric acid, it yields a sugar which remains liquid, and is further distinguished from arabin by yielding a blue flocculent precipitate with Fehling's solution.

Journal of the Chemical Society.

DESCRIPTION OF THE MACHINERY FOR A FACTORY CAPABLE OF MAKING 12,000 to 15,000 TONS PER ANNUM.

Steam Power.

4 Cornish steam boilers of 75 horse-power each.

1 2 horse-power engine.

1 Cylinder, or reservoir, to receive the condensed steam.

Washing, Cutting of Roots, &c.

1 8 horse-power engine, to drive the pump and machinery for lifting beet roots to the washers and cutting machine.

1 Mechanical beet root lifter.

2 Beet root washers.

1 Cutting machine.

2 Patent iron waggons, for bringing beet root slices to the diffusion apparatus.

12 Diffusion vessels, complete.

2 Iron waggons, for removing pulp to presses.

2 Presses (Klüzeman's system).

2 Tanks for providing hot water.

2 Tanks for providing cold water.

Defecation Charcoal Filters, &c., &c.

6 Copper defecation pans.

16 Iron tanks, of which 8 are provided with copper tubes (*serpentins*) for providing steam and carbonic gas.

1 12 horse-power engine (*pompe a gaz*), to punp the carbonic gas into above tanks.

2 Montejus for ditto.

1 Apparatus for making carbonic gas, complete.

4 Filter presses, to extract the juice remaining in the refuse after defecation.

10 Filters (charcoal).

1 Evaporating apparatus, consisting of 3 iron cylinders, provided with tubes, complete, called in French factories *triple effet.*

1 Condenser, for ditto.

1 Engine, 12 horse-power, for ditto (*pompe a vide*).

1 Apparatus for boiling the sugar (vacuum pan), with condenser, complete.

1 10 horse-power engine, for ditto (*pompe a vide*).

6 Montejus, in connection with the different parts of the manufacture, and sundry tanks.

Production of (grain) Sugar.

4 Centrifugal machines, complete.

1 6 horse-power engine, for driving the above, &c.

1 Montejus.

2 Tanks for receiving the sprup from the vacuum pan.

A number of tanks to contain the second and third produce. Copper pipes, &c., for conducting the juice to different parts of machinery. Tanks for storing water, preparing lime, &c. Charcoal furnace and charcoal washers. Sundry small apparatus, used in the second and third process.—*From Dr. Cameron's Pamphlet "On the Culture of the Silesian Beet."*

ON THE SWEETNESS OF SUGAR.

It is a familiar fact that all kinds of sugar have not the same sweetening properties, but the degree of variation is not by any means well known. This is due, in part, to the quality of the source whence it is derived, for where there is much grape or fruit sugar mixed with the cane sugar, as, for example, in beet-root juice (?), the sweetening property is lessened in proportion to the amount of fruit-sugar. In other part it is due to the process of manufacture, for the heating process converts cane-sugar into fruit-sugar, and the more so the longer the process is continued. Hence the first crystallization contains the greatest proportion of cane-sugar, and is the sweetest, whilst the quality deteriorates at every succeeding crystallization; and, finally, the treacle, or uncrystallizable syrup, consists largely of fruit-sugar. These qualities may be in great part determined by the size of the crystals, for it lessens as the quality deteriorates, and at length is supplanted by granulation, or bastard crystallization. The aim of the refiner is, therefore, to select a raw sugar which contains the least quantity of impurity, or any flavour distinct from that of sugar, and which also yields the greatest proportion of cane-sugar, whilst in the process he seeks to produce the largest and whitest crystals, and to cause the least quantity of granules or crystals to absorb the greatest amount of uncrystallizable syrup—that is to say, to make the greatest quantity of sugar and the least of syrup.

That kind should be preferred for domestic use which consists of the largest crystals and has the least proportion of moisture; and as respects loaf or lump sugar, considerable time should be allowed for the perfect solution of such crystals. A very raw moist sugar, which has a homogeneous appearance when rubbed between the thumb and finger, and a refined sugar, which is broken with comparative ease, and not of a pure white colour, should be avoided. It is also very useful to judge of sugar by the smell, for "pieces" and raw sugar from beet-root have an unpleasant odour, whilst pure sugars are entirely, or almost entirely, free from it.—*Foods, by Dr. Ed. Smith.*

STOCKS OF SUGAR IN THE CHIEF MARKETS OF THE WORLD ON THE 1ST MARCH, 1874, FOR THREE YEARS, IN THOUSANDS OF TONS, TO THE NEAREST THOUSAND.

	1874.	1873.	1872.
Great Britain	193	125	111
France	213	149	75
Holland	41	48	44
Germany (Zollverein)	48	44	29
Six other *entrepôts*	9	7	5
Total in Europe	503	373	264

CONSUMPTION OF SUGAR IN EUROPE AND THE UNITED STATES FOR THREE YEARS, ENDING 1ST MARCH, 1874, IN THOUSANDS OF TONS.

	1874.	1873.	1872.
Great Britain	788	736	676
France	246	217	313
Germany (Zollverein)	269	257	215
Holland	29	28	22
Six other *entrepôts*	106	104	115
Total in Europe	1,438	1,342	1,341

ESTIMATED CROP OF BEET ROOT SUGAR ON THE CONTINENT OF EUROPE, FOR THE ENSUING SEASON, COMPARED WITH THAT OF THE THREE PREVIOUS SEASONS.

(From Licht's Monthly Circular.)

	1873-74.	1872-73.	1871-72.	1870-71.
	Tons.	Tons.	Tons.	Tons.
France	395,000	409,000	335,000	289,000
Germany (Zollverein)	285,000	259,000	189,000	263,000
Austro-Hungary	175,000	214,000	162,000	182,000
Russia and Poland	150,000	150,000	90,000	135,000
Belgium	72,000	76,000	72,000	56,000
Holland and other Countries	37,000	35,000	25,000	17,000
Total	1,115,000	1,143,000	873,000	943,000

SUGAR STATISTICS—GREAT BRITAIN.

To April 25th, 1874 and 1873. In Thousands of Tons, to the Nearest Thousand.

	STOCKS.						IMPORTS.						DELIVERIES.					
	London.	Liverpool	Bristol.	Clyde.	Total, 1874.	Total, 1873.	London.	Liverpool	Bristol.	Clyde.	Total, 1874.	Total, 1873.	London.	Liverpool	Bristol.	Clyde.	Total, 1874.	Total, 1873.
British West India	17	3	1	14	34	22	20	4	2	6	32	24	22	2	1	11	36	39
Cuba	1	2	4	15	22	13	2	4	7	6	19	3	..	..	..	..	..	..
Porto Rico, &c. ..	1	9	..	..	10	6	1	10	..	..	11	8	1	9	..	..	10	6
Brazil	3	15	3	4	11	19	5	24	2	4	35	32	3	15	3	4	25	28
Mauritius	3	1	3	3	11	19	6	1	5	6	..	..	3	1	3	3	11	19
British East India	5	1	..	..	6	11	4	1	..	..	5	15	5	1	..	..	6	11
Manilla & Java ..	6	6	7	5	24	19	9	11	8	9	31	22	6	6	7	5	24	20
Beetroot, &c.	19	6	4	12	42	49	23	5	3	12	44	39	19	6	4	12	42	50
Total, 1874 ..	88	71	10	48	217	133	71	60	27	44	202	168	62	41	23	50	176	186
Total, 1873 ..	61	41	4	26	84 increase		54	49	23	41	34 increase		60	38	24	64	10 decrease	

STATE AND PROSPECTS OF THE SUGAR MARKET.

The raw sugar market has undergone little material change, so far as prices are concerned, since last month. On reopening after the Easter holidays the tone was dull and sales restricted; as, however, the night of the Budget approached, the idea appeared to gain ground that the Chancellor of the Exchequer would remove the duty, and this, together with the consideration that whether the duty were abolished or not, the uncertainty and unsettlement would be dispelled, imparted confidence in the future of the trade, and the market became firmer, sixpence advance being paid in many instances. Since the passing of the Budget resolutions this feeling of confidence has been confirmed and established, and the position of the trade is now commonly regarded as much improved, being, as we hope, permanently relieved from the periodical state of perturbation and depression which has for the last few years been consequent upon the Budget anticipations. When the change of system in the French Customs shall have taken effect, and a period shall have thus been put to the flagrant aggrandisement of the French refiners at the expense of their over taxed countrymen and to the ruin of the British sugar industry, it may, we think, be safely concluded that the healthy conditions of free trade which lead to prosperity have at length been secured.

Statistics show the stocks of raw in the country to be unusually large, 84,000 tons in excess of last year at this time; imports also are considerably in excess; accounts from Havana report, however, a deficiency in the crop there to the extent of 30 per cent. With regard to deliveries for consumption some falling off is apparent, but this is doubtless owing to the large proportion of the refiners who have stopped work, and is not to be regarded as a bad feature in the position.

Present quotations of standard qualities of raw are as under:—No. 12 Havana, afloat, 24s. to 24s. 6d., the same as last month; fair to good refining Cuba Muscovadoes, 20s. 6d. to 21s. 6d; middling to good brown Bahia, 17s. 6d. to 18s. 6d., showing in the two latter cases an advance of 6d. on last month's prices. On the whole, these quotations are about 2s. per cwt. below those of a year ago.

The refined market has, since the Budget, been much less depressed than was to be expected; there has been little or no abatement in price—indeed, in many cases, higher prices have been paid. Stocks of refined sugar are low, and immediate wants must be supplied. The price of common refined lump is now 32s. 6d. to 33s. 6d.

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☞ The writers alone are responsible for their statements.

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ON SUGAR REFINING.

By Frederick W. Griffin, Ph.D.

When I was requested to read a paper before this time-honoured Society upon the Sugar Industry, with which I am but indirectly connected, I felt at considerable loss how best to deal with the subject. Its full development would require, not one evening but many, whilst I should be unequal to do justice to it. I am placed at a disadvantage as compared with the able gentlemen who have preceded me in this course, inasmuch as I have no really new invention or facts to bring before you. I think, however, that by mainly confining our attention to the more scientific aspect of two or three special points, we may render the meeting not altogether unprofitable. I may say at once that as the paper is not likely to give rise to prolonged discussion, and as I have a good deal of illustration, I shall have to crave your attention for nearly the full period.

Considering the present enormous consumption of sugar, which has come to be regarded as almost a necessary of life, it is remarkable to note how comparatively recent has been its general introduction into Europe, which hardly dates four centuries back. Like most of the arts and industries, the manufacture of sugar took its rise in the far East, and has followed the sun's course westward round the globe. In China and India it has been made from the earliest times. Pliny describes the *saccharum* brought from India as "a honey from canes

like gum, white and brittle ;" and Humboldt considers the Persian and Arabic name *shukkur* identical in sound with our sugar, to be derived from the Sanscrit. The Crusaders seem to have introduced the knowledge of sugar into Western Europe on their return from the Holy Land. Their Monkish chroniclers speak of their chewing "a sweet honied reed called zucra" as a means of subsistence when their provisions ran short; and one of them gives the earliest description extant of the preparation of sugar from the cane as practised in Syria. Sicily appears to have been the first place in Europe where sugar was manufactured, and as early as 1148 considerable quantities were made there from cane grown on the island. · The cultivation of the sugar-cane did not attain any great development in the West, till it was introduced at the end of the fourteenth century by the Spaniards (probably by Columbus himself) into the West India islands, and subsequently to the neighbouring coasts. In 1676, the Barbadian sugar trade alone employed 400 vessels.

The process of refining was invented and first practised in Venice, then the centre of luxury, the supply of raw sugar being drawn from Egypt and Sicily. Antwerp became later the chief seat of the industry, and we largely imported refined sugar thence; but in the reign of Henry VIII. (about 1540) two sugar-houses were established in London, which for 20 years mainly suppied our demands. The use of sugar made rapid strides in this country. Hentzner, a German traveller who visited England in 1598, in describing Queen Elizabeth (then in her 66th year) writes, "her nose is a little hooked, her lips narrow, and her teeth black (a defect the English seem subject to from their too great use of sugar)." Undeterred by this somewhat apocryphal drawback, the English taste for sugar has gone on increasing till we now consume at least as much as all the rest of Europe put together; more than a pound per week for every man, woman, and child in the United Kingdom. Indeed, the great Counterslip Refinery (to which I shall have to allude presently) alone furnishes more than 4 lbs. per head yearly, which is probably an eighth part of the total sugar refined in the kingdom.

I will briefly describe the production of raw sugars, in which I shall

be aided by some of the pictures prepared to illustrate Professor Gardner's interesting popular lecture on "Sugar," at the Polytechnic Institution, and which (with various specimens and models) he has most kindly lent for this occasion. These we will throw on the screen behind me by the electric lantern. Large quantities of good sugar are produced in Canada and the Northern United States from the sap of the sugar maple, a forest-tree which attains a height of 60 or 80 feet, and by the brilliant crimson of its fading leaves, adds much to the beauty of the autumnal scenery of those districts. The trunks are tapped about February, as practised by the Indians before the colonisation of the country, and the collected sap is boiled down to granulation and drained. The produce is consumed at home, and (except a portion made from the root of the beet) the whole of the raw sugar refined in this country is obtained from the sugar-cane. This is a gigantic reed belonging to the invaluable family of the grasses, which grows to a height of from 10 to 15 feet, and is propagated by cuttings taken from the top-joints of the stem. Like other grasses, the sugar-cane is stiffened by a hard silicious cuticle or rind, and is further strengthened by annular joints or knots at short intervals, from which spring the leaves, and in the cuttings the rootlets beneath, and the young plant above. These cuttings are set in small trenches, about eigth inches deep, and at the least five or six feet between the rows, but they are now more generally laid four to six feet apart in shallow furrows, formed by a small plough. The leaves are large and drooping, three to five feet in length, so that the plant has a handsome appearance when growing luxuriantly in masses. (In the *Victoria Regia* house at Kew Gardens the sugar-cane may be seen in vigorous growth.) The Tahiti cane (of which there is a stalk on the table, and from which the fine Mauritius sugar is made) has to a great extent replaced the common or "Creole" cane from India, as it is harder, quicker, and more luxuriant in growth, and affords a better yield of sugar. When the leaves have fallen off and the stalks become yellow (which is in ten to twelve months for the Tahiti, and twelve to fifteen or sixteen for the Creole cane) they are cut off close to the ground, and immediately carried to the crushing mill for the expression of their

abundant saccharine sap, which constitutes 85 to 90 per cent. of their total weight when fresh, the woody fibre and rind not exceeding 10 to 15 per cent., hence the interior is very soft and spongy. The mill consists of three or five large iron rollers kept slowly revolving as the canes are drawn and crushed between them. All this machinery (the fly-wheel more especially) requires to be very strong and massive, from the irregularity of feeding and action causing much jerking and strain on it. In the Great Exhibition of 1851 we used to see stout deal boards passed through the cane mill shown by Messrs. Pontifex, and emerging as a soft pulp. These mills were formerly driven by the wind, but this uncertain motor is now replaced by steam, the fuel for raising which, as well as for the subsequent operations, is chiefly the crushed cane dried in the sun or by the waste heat of the fires. For each horse-power of the engine about 100 gallons per hour of expressed juice is obtained. This is an opaque, frothy, yellowish liquid, of a faint but agreeable balsamic smell, and containing about one-fifth of its weight of sugar, which is all crystallisable. This is first clarified and rendered more stable by heating at once with a small quantity of lime made into a cream with water, and called "temper." This coagulates and partly carries down the albumenoid nitrogenous matter, which would speedily give rise to fermentation. The clear yellow liquor is heated more and more strongly in a series of pans, the calcareous scum which forms being carefully skimmed off, and it is then boiled down till on cooling n large tanks it will "grain," or imperfectly crystallise. The moist mass so obtained is drained for several weeks, to allow the liquid molasses to run off as much as possible before packing in hogsheads or bags for shipment. The boiling down used to be carried on with little care, and at a high temperature in open pans, whereby much molasses was formed at the expense of the sugar, rendering it dark and clammy, thus deteriorating its value and causing great loss of weight by leakage during the sea voyage. Dr. Evans remarks :—" Had the planter intended to convert the cane juice into birdlime, he could scarcely have invented a more successful method of accomplishing his purpose." This wasteful

system had been superseded in Java, Mauritius, Havana, and many of our own colonies by the use of the vacuum-pan and other improved processes, whereby a very superior class of sugars is produced, more profitable alike to the producer abroad and the refiner at home.

Professor Gardner has kindly lent me an excellent working model of a vacuum-pan, which I will devote a minute to showing you in action. We will suppose this liquid to be a syrup boiling down under ordinary conditions, when its temperature would be above 212°. At this heat the purest sugar solution like this would rapidly darken and pass into the state of uncrystallisable treacle. If the pressure of the air is removed by a powerful exhaust pump, joined to a condensation of the vapour by cold, the syrup will boil nearly 100° lower, so that the change will be comparatively very small and the syrup little discoloured. We remove the flame and close the exit pipe while this vessel is full of steam, elastic as the air. If we pour cold water on the outside, the steam will be condensed, and the syrup being relieved from pressure by the vacuum so formed, will start again into ebullition and continue to boil till it has greatly cooled down. In a good vacuum-pan we can bring the pressure down to a single inch of mercury, instead of the ordinary 30 inches, and the syrup will then boil as low as 120°, and even that will render this white liquor yellow. These vacuum-pans are of copper, heated by steam circulating through coils of copper tubing, and are often of gigantic size. I will show you a photograph of one of the largest in existence, which is at work in Messrs. Finzel's refinery, where an even larger one is being erected. This is about 12 feet in diameter, and will work off nearly 30 tons of sugar at each boiling.

The maximum of bad manufacture is reached in the Jaggery made by the native Hindoos by methods unaltered from immemorial times. Much of this is refined in this country, though its use is hardly to be commended, containing, as it does, all kinds of filth. The cane is crushed in a rude wooden mill resembling a huge mortar and pestle, and the juice is simply boiled down in earthen pots till it forms this nearly solid half-burnt mass, containing, according to my determinations, only 73 to 77 per cent. of crystallisable sugar.

Before passing on we will throw on the screen a copy of the chart prepared for the museum of the Royal Gardens at Kew, to show the distribution of the sugar-cane, the areas occupied by its cultivation, or in some cases those which are peculiarly suited to it, being coloured red. You will observe that this is the case with the peninsula of India; parts of China and Australia; Java, Mauritius, and other islands; a portion of the south-eastern division of Africa, and the Gold Coast on the west; and the West India Islands, with Brazil, and immense tracts of North and South America.

You cannot fail to note that all these localities possess a tropical or sub-tropical climate, and are situated not far from the sea coast, considerable heat and moisture being essential to the full development of the cane. Dr. Livingstone, however, found it much cultivated along the Zambesi river towards the interior of Africa. The climate of southern Australia seems well adapted to the growth of the cane, and its cultivation is rapidly extending. Excellent Australian sugars were shown in last year's International Exhibition, but for some time to come the whole of the produce of the colony will be required for its own consumption. Our latest acquisition, the Fiji Islands, may some day yield us a supply of raw sugar, as the cane thrives well in them. Here is a sample of the sugar badly made there at present, so that it is of low quality, and marks only 83 per cent.

By far the greater part of the sugar consumed on the Continent is made of beet-root, which in the fresh state contains about 12 per cent., and, unfortunately for us, a considerable amount of this sugar (last year 26,000 tons), is imported into this country. I say, unfortunately, because it is of far inferior quality to that produced from the cane. The sugar is accompanied in the expressed juice by considerable quantities of various nitrogenised principles, which are estimated to amount to 11½ per cent. of the weight of the dry beet, or nearly one sixth as much as of the sugar itself. These nitrogenous matters induce fermentation and all kinds of chemical changes, and can only be eliminated by the highest refining. Moreover, even the manufactured beet-sugar is saturated with an essential oil of a most offensive glue-like smell, very disgusting when the

sugar is in quantity, and difficult to get rid of entirely. I will pass round a specimen of raw beet-sugar that you may smell and judge for yourselves.

The manufacture of beet-sugar took its rise in the exigencies of France when commercially isolated during the wars of the first Napoleon, and it has attained to huge proportions. The production in Europe in 1843 was only 55,000 tons; ten years later (1853) it had nearly quadrupled, being 200,000 tons; in 1863 it was 452,129 tons, more than double; while last year (1873) it had reached the immense total of 1,142,896 tons, more than one-third the amount of cane-sugar produced by the whole world, which is estimated to have been that year a little under three millions (2,954,722) tons. This extensive cultivation affords large agricultural employment, and keeps down the price of sugar abroad, hence it is a great boon to continental Europe. The introduction of its produce into this country is, however, much to be deprecated, as if it cannot be called a true adulterant of the more wholesome and palatable cane-sugars which are so abundantly supplied to us by our colonies and commerce, it is at least a deteriorant, if I may be permitted to introduce such a word.

Now the first concern of the refiner, like other manufacturers, is with the quality of his raw material. Crude sugars, as imported, vary much in their saccharine richness, which ranges from about 75 to 98 per cent. of pure crystallisable sugar. Practical buyers acquire by experience considerable skill in judging of the refining value of a raw sample from its colour, feel, smell and taste; its hard, sparkling "grain," or soft, dull character; but even their conclusions are sometimes found to be very erroneous when brought to the touchstone of scientific analysis. Hence the accurate valuation of the raw sugars offered in the market is of paramount importance and demands the closest attention. We will enter on it in some detail, all the more because it is my special field. Various processes have been devised, but only two widely adopted, a chemical method and an optical one. The chemical process, due to Barreswil, a French chemist, though the earliest, was introduced no

longer than thirty years ago (1844), and is based on the reaction between glucose sugar and the salts of copper, whereby the sugar becomes converted into oxidised acids by taking away part of the oxygen in the oxide of copper. I add caustic soda to a solution of sulphate of copper ; the alkali seizes on the acid of the metallic salt, displacing the oxide of copper, which falls as a blue precipitate. If we previously mix the solution of copper with an alkaline tartrate, such as Rochelle salt, no such precipitate appears, but the liquid becomes of an intense blue colour. (The tartrate appears to form a sort of double salt with the copper, which alkalies cannot decompose.) If this blue liquid is boiled no change takes place, nor yet when it is mixed with pure cane-sugar ; but the smallest trace (even a millionth part, according to Trommer) of the glucose found in fruits and honey, and into which cane-sugar readily passes under the action of acids or ferments, will determine an immediate change. The oxide of copper will part with half of its oxygen to the glucose, and be reduced to suboxide, which is no longer held in solution, but falls as a yellowish powder, becoming dense and dull red on boiling. This can be collected and weighed, with suitable precautions, and indicates the presence of as near as may be one-half its own weight of glucose. Thus if we took 100 grains of a sample of raw sugar, dissolved it in water, and boiled with an excess of this tartro-cupreous solution, obtaining a precipitate which weighed 8 grains, it would show, to begin with, that our sample contained 4 grains, or 4 per cent. of fruit-sugar, which is practically uncrystallisable. But what we chiefly want to know is the proportion of cane-sugar in the sample. To arrive at this, we must take a second 100 grains, and boil its solution for some minutes with about one-fortieth of its bulk of hydrochloric acid. Under the influence of the acid and heat, the cane-sugar will fix the elements of water and pass entirely into the state of glucose. On repeating the process, we might find the weight of the precipitated sub-oxide of copper to be as much as 202 grains. From this we deduct 8, due to the pre-existing glucose which we determined in the first trial, leaving 194, which corresponds to a little over 92 of cane-sugar. Our sample consists therefore of

92 per cent. of cane, and 4 per cent. of fruit-sugar, the remaining 4 parts being salts, sand, extractive or colouring matter, and moisture. I have spoken, for the sake of simplicity, of employing 100 grains of the sugar, but in practice we should only use 5 or 10 grains, so that this becomes a delicate analytical operation. It is also a somewhat tedious one, involving the thorough washing and drying of the precipitate, so that we only resort to it for syrups and raw sugars of low quality, as the dark colour of the liquid is immaterial. For ordinary samples, a much more expeditious way of applying the test is to take a measured volume of the standard copper solution, heat it to boiling, and add from a finely-graduated burette a very weak solution (containing at most 1 per cent.) of pure sugar, which has been changed to glucose by heating with an acid, until the last trace of the blue colour just disappears on boiling. If ten measures are required with pure sugar, whilst eleven are needed with an equal weight of the sample dissolved in the same bulk of water, a simple calculation will show that it contains a trifle under 91 per cent. of sugar. Of course in this case also a double trial has to be made; the first to determine the amount of glucose in the sample, and the second to ascertain the extra quantity when we have artificially converted the cane-sugar into it.

The results are accurate enough in skilful hands, but the process requires great care, with very delicate weighing and measuring, since from the smallness of the quantities operated on, any error becomes seriously multiplied in the percentage results. But there is a yet more serious drawback. The test-liquor will alter by keeping, so as to give a precipitation by heat alone, which in either modification of the process would count as so much sugar. This obliges us either to throw away at once the standard solution prepared at some cost of time and trouble, or to determine the amout of precipitation and deduct it, which opens a wide door for error when the work is in careless or unscrupulous hands. The chemical method has therefore been in great measure superseded, both here and abroad, by the optical one, which is expeditious and in most cases exact. This brings to our aid the most recondite phenomena of that marvellous

force called light. The optical saccharimeter invented by Biot, and brought into practical shape by the skill of the elder Soleil, was rendered precise and easy in its technical application by the labours of Clerget. To explain its principles in full would require a succession of lectures, but I will endeavour to give you in few words a notion of the fundamental facts on which it is based, aided by Mr. Browning's large electric polariscope. We will allow a small beam of light to emerge from the lantern which will produce a spot of light upon the screen. If my assistant places a rhomb of calc-spar in the path of that ray, it will be split into two divergent ones, producing two spots of light upon the screen, and on turning round the crystal, the spot formed by the ray which is most refracted or bent out of its course, and which is called the extraordinary ray, revolves round that formed by the ordinary ray, which is but little deflected. This doubling of the ray is entirely due to the molecular arrangement in the substance of the calc-spar itself, for the thicker it is the wider apart will the images be separated, while glass or rock-salt cut into the same external shape will produce no effect of the kind. Now the eye cannot detect any difference between the rays which have passed through the crystal and produced those spots, and that which is now simply streaming from the lantern; but if we examine them more closely, we shall find they have been profoundly modified. This beam would pass, as you see, through a crystal of calc-spar held in any position, doubled it is true, but still perfectly freely; but if a second rhomb of calc-spar were placed in a proper position in front of the first, we should find that only one of the rays would pass, the other being completely snuffed out. If we slowly revolved this second crystal, we should find that the bright spot would begin to fade and the other to appear dimly, till, at the half-quarter revolution, both would be equally bright. At the full quarter, or 90°, the ray which had first passed with freedom will be completely extinguished, while that which before was stopped out will alone be seen. Twice in every revolution we should have the image formed by the ordinary ray, and that alone, and twice the one given by the

extraordinary ray, and that solely. The beam seems to have acquired sides as it were, or rather properties which are opposed to each other in the opposite directions, a sort of *polar* character which suggested the name "Polarised" for light thus modified. We may call the crystal which produces this change the "Polariser," and the second one which tests the condition of the modified light, the "Analyser." But in applying this polarised light to a lantern, for purposes of demonstration, or to a microscope as an aid to working out delicate structure, we do not want two images or a double field, and this was ingeniously got rid of by Mr. Nicol, of Edinburgh. He cut off the acute angles from the rhomb of calc-spar, and cemented them together by transparent Canada balsam, so as to form a rhomboidal prism which is still known by his name. This bends or turns aside the extraordinary ray so much further than the natural crystal would, that it is thrown against the opaque blackened fitting, and is there absorbed and lost, and only the ordinary ray emerges into view. A large Nicol prism is now fitted on the front of our lantern, and we have a disc on the screen which is formed by the ordinary ray of the pair really produced by the prism, and this is entirely polarised. If we placed in the path of this ray a piece of glass of any shape, the beam would pass with equal freedom in any position, and the same is the case with this second Nicol prism if the optic axes of the two prisms are parallel. But turn the second, or analysing prism, a quarter of a revolution, and you see the light is as completely blocked out by it as if it were a plate of metal instead of a glassy crystal. Turn the analyser round slowly, and the light will begin to pass till at the next quarter revolution the disc will again be bright. Thus, in each rotation we have this succession—bright, dim, dark, dim, bright, dim, dark, dim, and then bright, as we started. Now, doubly-refracting bodies will depolarise light, that is, restore it to its ordinary normal condition. We will place between the prisms, when their axes are crossed, so that we have a black field, a slice of such a substance, which might be mineral, animal, or vegetable; a cutting of calc-spar, of quill, horn, or muscle; but we may more appropriately take a section of

the sugar-cane, which has been prepared for me by Mr. Barnett, the skilful microscopic mounter, of Tottenham, who has also smaller sections under the microscopes, polarising and otherwise, on the table, which you can examine after the paper, if time permits, and so see more of the structural arrangement. The sugar-cane, however, does not sectionise well, as it is so soft and vascular. However, there is its image traced in light upon the black ground, for every ray which has passed through its substance has lost its polar character, and can therefore freely penetrate the analyser, while all the still polarised rays around are stopped back by it. If we interpose between the crossed prisms a film of selenite (which is likewise a double refractor) of a certain thickness, the beam will pass freely in all positions of either of the prisms, and will also display a rich colour, the thickest film giving a red, the thinnest a violet. If the selenite film be rotated, the colour will be vivid at each quarter revolution, and nearly disappear at the intermediate points. If it remain stationary, and either prism be rotated, a still more remarkable effect will be produced. The colour will fade away to the 45°, but at the quadrant it will not re-appear as before, but be replaced by its "complementary," that is the colour with which it would produce white light. At the semi-revolution we get the original colour, and at the third quadrant the complementary again. Thus, if the original colour is red, we have the following order in each revolution—red, colourless, green, colourless, red, colourless, green, colourless, to red again as at first. If we started with blue, it would alternate with orange, and purple with yellow. If we take a wedge of selenite, we shall find it crossed with rainbow-like bands of the prismatic colours, and if we examine a slice of many crystals cut across the optic axis, we shall have these bands arranged circularly round the axis, which is generally the centre of a cross, black or white, according to the position of the prisms. Sugar shows this very well, as you see in this section of a fine crystal of it. A slice of quartz (also cut across the axis) acts in a remarkable manner. It twists the polarised ray round a considerable distance, to the right in some crystals, to the left in others, which are called

accordingly "right-handed" or "left-handed" quartz. It also colours the ray according to its thickness and position, like selenite. This twisting of the ray is almost peculiar to quartz among solid bodies, but it is exhibited by various organic substances when in solution, and by none more markedly than by sugar, and curiously enough its two chief modifications answer exactly to the right and the left-handed quartz; cane-sugar turning the ray to the right, and glucose to the left. If we interpose a vessel filled with solution of sugar between the prisms crossed so as to give a black field, the beam will at once pass, and we shall have to rotate the analyser a certain number of degrees (which can be exactly measured) before the light will again be extinguished. The amount of this deviation is strictly proportionate to the quantity of pure dry sugar present in the liquid. If a certain solution, so examined, marks 40° on the scale, and we dilute it with an equal bulk of water and try it again, it will mark exactly 20°, or half as much; and so for all dilutions. Here then we have a precise measure of the quantity of sugar present, and by taking equal weights of pure sugar, and of any sample which we wish to try, dissolving them in the same volume of water, and filling the tube of a suitably arranged instrument with the solutions, we can accurately compare one with the other, and so arrive at the percentage of the sample. Many points, however, have to be provided for, which is admirably done in this beautiful instrument, the Soleil saccharimeter, now best constructed by Duboscq, of Paris. The light employed may either be daylight or artificial; that from a paraffin lamp is best, as it is white, pretty constant in quality, and always at command. It enters the instrument through a small circular hole at the back, and is polarised by a Nicol prism rendered achromatic. The extraordinary ray is turned so far aside as to be "stopped out," and only the ordinary ray, perfectly polarised, passes on. At the other end we have an eye-piece and an analysing prism, the rotation of which would render the field alternately bright and black as you saw just now. But we have here a plate of quartz which acts like a selenite in making the field always light, and at the same time coloured according to its

thickness and relative position. The tint of this plate is the point to which we work, and it is cut to such a thickness (·14763, or 1-7th of an inch) as to produce, when the axes of both prisms coincide, a pale violet, called by Biot "*teinte sensible*" or "*teinte de passage*" (the sensitive or transition tint), as the slightest displacement of the prisms makes it incline more toward pink or blue according to the direction of the movement. This plate is, however, really composed of two half-discs, the one of right-handed and the other of left-handed quartz, so that when we look through the eye-piece we see a circular field caused by the image of the round aperture, and crossed vertically by a dark line which is the join of the semi-discs. The two halves of the field may show a variety of colours, but when the prisms are adjusted so that their axes are precisely parallel, both will be of the pale violet "sensitive tint," as you see in this painted diagram. If we interpose a tube filled with solution of sugar, we upset the equilibrium altogether; the colour will be wholly changed and the two halves will assume opposite colours, for the rotatory power of the sugar, if cane, will be added to the similar action of the right-handed quartz of the one segment, and lessen to an equal extent the left-handed rotation of the other. The field may then show one half green the other orange. To restore the original state of things we must precisely neutralise the action of the sugar, and this is ingeniously managed by the "compensator." This consists of two long wedges of quartz, thickest at the ends, which can be slid over each other, backward and forward, just behind the eye-piece, by a pinion worked by a button so as to make their joint thickness greater or less. For cane-sugar the zero has to be moved towards the left, when the halves will change to red and blue, and then approximate closer and closer, till at the exact point of counterbalancing, the whole field will present the original pale violet tint. The frames containing the wedges carry graduated plates on the top, so that the amount of movement can be read off, and the division is so arranged as to show the percentage at once without calculation. Thus, pure sugar would mark 100 on the scale, or 100 per cent. But the quartz

wedges are of a certain thickness at the point marked zero, and this would interfere with the action of the semi-discs, so that it must be neutralised. This is effected by placing behind the compensator a plate of quartz of the opposite rotation (left-handed if the wedges are right-handed) and worked to precisely the thickness of the double wedge when set at 0, so that its action is virtually extinguished. So much for the instrument. The sugars must be examined under precisely similar conditions, so we take a certain definite amount of the sample. This brass weight furnished with the instrument is marked 100 (it weighs about 254 grains) and that quantity of sugar dissolved in 100 cubic centimetres of water will, if pure, mark 100 divisions on the scale. If the sample contain only nine-tenths of its weight of pure crystallisable sugar it will read 90, and so forth. We accurately weigh out the sugar to be tried on a counterpoised watch-glass, transfer it through a glass funnel to one of these flasks, rinsing all the surfaces clean with a jet from the washing-bottle, shake at intervals till the sugar is dissolved, then add water to bring the level to the mark on the stem indicating 100 c. c., and fill up the tube of the saccharimeter with the solution. This tube is 20 centimetres (a little under 8 inches) long, and is closed liquid-tight by discs of plate glass, screwed down by these brass caps. If all sugars were nearly pure, and their solutions colourless, this would be all that would be needed, but raw samples have more or less colour, and this must be removed, as anything beyond the feeblest yellowish tint seriously degrades the sensitive violet, and renders the observation less easy and precise. We decolorise by adding a little solution of sub-acetate of lead (which coagulates some of the impurities) to the liquid in the flask, then make up to the mark on the neck, and treat with one-fourth of its bulk of bone-black. This powerfully absorbs the colouring matter, as in the actual refining. The French method is to pass the solution through granular black contained in a narrow tube, a plug of cotton wool at the bottom straining it off clear. I greatly prefer the use of black in fine powder, agitating the solution mixed with it briskly for a few minutes, and then filtering through paper. This decolorises far

more perfectly, rendering solutions of somewhat dark Havana and other sugars as colourless and limpid as water, but I am not aware whether it has been tried by others. When time allows, it is well to filter several times through the black so as to get the maximum decoloration, as the subsequent polarising is rendered all the more precise. Books generally say the solution, "decolorised if necessary," &c.; but the treatment with the black is not optional, but indispensable, even with the purest sugars, or serious errors would arise. The scale of the "Soleil" is graduated to show the correct percentage after the solution has been treated in the usual way with black, which absorbs and retains a certain amount of sugar. (The first portions of a syrup run through fresh black will show five or six per cent. less sugar than the remainder of the liquor.) Hence, if we omit the treatment with charcoal, whether it be needed for decolorisation or not, we shall get our results too high. In a careful verification of this instrument, I found that the standard weight of pure sugar uniformly showed not 100, but 102 on the scale, and that this was not due to errors in construction was proved by taking 150 of sugar, which gave 153, an excess in the same proportion. When the solution was previously treated with grain-black in the French manner, I constantly got the correct reading of 100 or 150 within the trifling limits of error. The dust-black, from its great extension of surface, absorbs rather more sugar, and gives a constant deficiency of about half a per cent., which may be added to the observed figure. Landolt, of Bonn, considers the errors of observation with different observers using different instruments, to be within 1 per cent. For myself, using the same instrument, I should place it at half a per cent., for repeated determinations of the same sample at different times do not vary more than that from each other, and are often sensibly identical. I do not mean to say that even 1 per cent. will give a decided difference in tint between the halves of the field, but by turning the button carefully, as we make it alternately pink to the right and pink to the left, the educated touch can place it midway with considerable precision. Greater delicacy would be

desirable, but as it is practically extremely difficult to obtain samples which represent the real average of a large bulk of raw sugar, even so nearly as that, we the less feel the want of closer results. Great care is required in all the manipulations, and the liquids should be of the temperature of the air of the room, which should be pretty constant. It is immaterial whether we work at 50° or 70°, but the sugar solution must not sensibly alter in temperature after it has once been made up to the standard bulk, as any expansion or contraction would make it virtually weaker or stronger. When there is a sufficiency of the sample, and it is not below the medium colour, it is well to take 150 parts instead of 100, as the errors of observation remain the same, and so are somewhat lessened when the result is reduced to two-thirds to obtain the percentage. With darkish solutions of low sugars we have to shift a particular tint from right to left, and take the mean of pretty concordant observations of both limits. This can, of course, only give approximate results; hence perhaps the chemical or copper process is better for syrups and very coarse sugars. This gives figures with such samples even 2 or 3 per cent. above those of the polariscope, which we know to be somewhat too low; but it is by no means certain that the copper results are not too high from a reducing action of some of the indeterminate impurities of these low samples.

I may say a few words as to the average percentage of raw sugars as determined by some thousands of careful polarimetic observations. The most constant in quality is Java, which seldom falls below 96 and ranges from that to 98 or even higher. Fine Mauritius ranges from 95 to 98, but the syrupy kinds hardly average more than 90 or 91, some being as low as 86 or 87. Havana varies widely; the ordinary kinds generally run from 91 to 95, 93 being a very frequent percentage, but some of the finer kinds rise to 96 or 97, and I have found exceptional boxes nearly pure, showing 99 or even 99½. The second-class, as West India (Demerera, Barbadoes, Trinidad, Cuba, &c.) and the still inferior Brazilian sugar (Pernambuco, Bahia, Paraiba, and others) vary so much, even in different parts of the same cargo, that it is almost impossible to give a special average

for each. Collectively they range from 80 to about 93, but it is only exceptionally good cargoes which much exceed 90 in actual out-turn. It is notable that while fine sugars, Java, Mauritius, or Havana, generally land nearly or quite equal to the shipping sample by which they were bought, the inferior kinds are usually considerably below it, and the more so the lower the quality; in some cases 2, 3, even 4 per cent. less. This may of course arise from the sample having been unfairly taken, so as not to represent a true average of the bulk, but it may also proceed from deterioration on the voyage. Such sugars are always moist and acid, conditions highly favourable to the change of cane-sugar into glucose, especially in the damp hold of a ship under a tropical temperature. I can only speak to the fact, which is apt to mislead the refiner in buying. Nor are the analyses of experts to be too implicitly relied on. Here is a fine Mauritius, which on repeated trials was found to be 97 per cent. (this is an instance by way of the shipping sample and the bulk of the cargo precisely agreeing). On the bottle is a pretentious-looking analysis, which sets it forth as 94¼ per cent only. This is by a commercial tester, a druggist, and—pray do not laugh, though the fact would be ludicrous were it not pitiable—also a public analyst for food and drugs under the Adulteration Act. I would that time allowed me to dwell, even briefly, on this precious legacy of the science-scorning Cabinet of Ayrton and Lowe, for it is one of the most mischievous bungles ever perpetrated by an English Government. Even as it is now worked, it is tyrannical towards the smallest offenders, whilst gigantic frauds and wrong doings are passed by, and the public is deluded into a false sense of security. As to the motley tribe of public analysts, surgeons, druggists, all sorts of smatterers and pretenders, with a few bright exceptions—dumb dogs which cannot bark, or bark in the wrong note and season—their doings threaten to bring analysis, nay science itself, into general contempt. The Act must soon be altered—possibly without being improved—and I only allude to the subject to offer a suggestion. The Society of Arts has launched or aided many valuable public movements, and I think could scarcely undertake a

more worthy task than to bring to a focus for the guidance of our Legislators, concurrently with the report of the Parliamentary Committee now sitting, the opinions of those really competent to form a a correct judgment on this vital but difficult question.

Besides its value as a palatable adjunct to our food, sugar is important in a dietetical point of view. It forms a valuable element in the production of the vital heat through respiration, and is undoubtedly fattening. (Indeed, one of the benefits of the abolition of the sugar duty will probably be the large consumption of the inferior kinds by the agriculturist for the fattening of stock.) Hence it becomes of consequence that we should clearly understand the relative advantages and drawbacks of the different forms of sugar. Raw sugar (which is most favoured by the grocer) is decidedly objectionable unless of the very finest quality, and it is so mixed and manipulated that it is difficult to make sure of that. It contains considerable quantities of woody fibre from the crushed cane, which has not been separated by filtration; often much gritty sand; innumerable sporules (or *quasi* seeds) of fungus; colonies of the sugar-mite; nitrogenous matter; and treacle, or glucose in its different forms. Let us glance at these in succession. The woody fibre is simply indigestible; the sand attracts attention when the sugar is dissolved in tea or otherwise, and is popularly supposed to be added by the grocer. I cannot say whether the charge might ever have had any real foundation when sugar was much dearer than at present, but low sugars when imported frequently contain a notable amount of sand whose accidental introduction could not be readily accounted for. In a small cargo Messrs. Finzel once found 12 tons of sand, but, of course, this was an extreme case. Stones, lumps of rock, and old iron; in one instance a cannon-ball; in another a set of slave-manacles have been found at Counterslip in West India hogsheads, to be paid for as so much sugar. Well, sharp, angular sand is certainly not a desirable ingredient in a cake or pudding. *Fungus spores* are deleterious from the extreme rapidity with which, under suitable conditions, they develop into a spreading vegetable growth; but more objectionable still is the animal product of the

sugar, the *acarus sacchari*, of which I will show you a photograph. This was first described by Dr. Hassall, who may be termed the father of modern anti-adulteration science, which is also deeply indebted to our chairman. He characterises it as oval in shape, with eight jointed and spiny legs armed with formidable hooks, and altogether similar to the itch-insect, than which, however, its organisation is still more formidable and forbidding. It seems to burrow under the skin in the same way, producing the irritating pustular disease known as "grocer's itch" from its attacking those who are constantly handling raw sugars. Such living beings can hardly fail to be injurious when swallowed, especially as they are difficult to kill. Dr. Hassall remarks:—"The acarus clings to life with great tenacity, for very warm water does not always kill it, and it may frequently be found in a living condition even after twenty hours' immersion." This persistent vitality joined to their burrowing powers renders the presence of these creatures in our food the more obnoxious, and they exist in nearly all raw sugars. Hassall found them in 78 out of 83 samples of brown sugar purchased in London, and in many, in considerable nnmbers. Dr. Cameron, the able and indefatigable sanitary chemist of Dublin, estimated that the sugar supplied to one of the workhouses there contained at least 100,000 to the pound. It is the nitrogenous matter which supports the existence alike of fungus-germs and acari, and the relative abundance of these is a pretty correct measure of the proportion of the albumenoid principle. As I have said before, most nitrogenous bodies are not only unstable and prone to decay themselves, but impart their own changeability to other organic materials, with which they may be in contact. Hence a solution of brown sugar will speedily ferment and turn sour, and jam made with it, unless boiled down hard, will quickly spoil, although pure sugar is one of the best preservatives. The last item, the treacle, is the source of the coarse saccharine flavour which attracts the uneducated palate, and quite as much as fancied economy renders raw sugar popular with certain classes; but the inferior kinds are far from cheap, as they are extremely heavy. Dr. Hassall, as the result of his in-

quiries, "felt compelled, however reluctantly, to come to the conclusion that the brown sugars of commerce are, in general, in a state wholly unfit for human consumption;" and Dr. Cameron writes:—"In the interest of the consumer I advocate the exclusive use of refined sugar. I unhesitatingly assert that no one who pays any attention to the purity of his food, and is aware of the nature of the impurities so frequently abounding in the raw article, could, without a feeling of loathing, make use of it."

The white moist sugar of the shops, technically called "pieces," is free from woody fibre, sand, fungus spores, or acari, since it has been refined; but it is often moist and clammy, so as to weigh heavy in proportion to its sweetening power, and as it is frequently made in part from raw beet-sugar, it is apt to retain traces of its offensive volatile oil, and its abounding nitrogenous matters, rendering it liable to ferment.

Before, in conclusion, speaking of lump and crystal sugars, I must remind you that the separation of pure sugar from the syrup, containing glucose, colouring matter, nitrogenised principles, and various salts, depends on the marvellous phenomenon of crystallisation. As an illustration, I will instance nitre. Hot liquids dissolve a larger amount of most salts than when cold; boiling water dissolves twelve times as much nitre as water at 60° can either take up or retain. Hence, as a solution of nitre saturated when boiling cools, the greater part of the previously dissolved nitre will be deposited, and as its particles when separating from a mobile liquid have perfect freedom of motion, they balance themselves into that special geometrical shape which is as characteristic of many bodies as their colour, smell, or taste. See how the particles of nitre by unerring molecular attraction have formed into a regular figure, which in their case is a long six-sided prism, and built up their perfect structure, atom by atom, with a precision which art cannot equal. Such processes have been going on around us from the birth of time, and will continue to the end, yet I confess I can never look on them without fresh wonder and admiration. Different substances crystallise in different forms, while others refuse to crystallise out from a liquid at all, and on this rests the purification

we seek. The impurities of crude nitre are colouring matter, which will not crystallise, and common salt, which forms cubes, having no relationship whatever to these long crystals, hence they will both be separated. The mason when building a wall would never try to fit a square block into an oblong hole, nor to fill up the gaps with a liquid; neither will the nitre. The square blocks of salt are rigidly excluded from its minute architecture, and the still-liquid colouring matter can find no place in it. So with a solution of sugar. The sugar atoms build themselves up into short six-sided crystals which reject every trace of the salts and treacle, the colouring and nitrogenous matters of the syrup. The substance of the sugar crystal will be as pure as the force of nature, controlled by art, can render it. Ice crystallised out from sea-water in icebergs is perfectly free from salt, and Faraday found that the ice from Norway and the North American lakes was absolutely pure though from water by no means so. I will endeavour to demonstrate this purification in a manner visible to the eye. We have in this glass a solution which was saturated while hot with sulphate of soda, mixed with a considerable amount of carbonate of soda, which for our present purpose we may look upon and call the "impurity," to be got rid of in refining. As the liquid cooled, a large portion of the sulphate of soda crystallised out, attaching itself to a weighted line, by which we can readily lift it. I will set the mass to drain for a minute or two, while I add some hydrochloric acid to the liquid from which it has separated. This produces, as you see, a most copious effervesence, by setting free the carbonic acid gas of the large quantity of carbonate of soda actually present. I will add much of the same acid to the water in this glass, in which I will hang the mass of sulphate, after rinsing its surface by dipping it two or three times into clean water. There it is dissolving tranquilly in the acid without a bubble appearing, so that it can contain no trace of carbonate, which was all left behind in the mother liquor. You will see this better if we throw the magnified image of the whole upon the screen. You observe dense streams of the heavier solution pouring down from it, showing that it is rapidly dissolving, but no solitary bubble tells of a taint of

carbonate; it is sulphate of soda chemically pure, and so is sugar when similarly obtained in bold regular crystals, the surfaces of which have been properly rinsed and cleansed. I had intended to give some experimental illustrations of this, but I found time would not permit. Pure sugar-crystals were introduced to the market 25 years ago by the late Mr. Finzel, of Bristol. There are some peculiar points connected with their manufacture. If the concentrated syrup boiled down in the vacuum-pan were simply run off slowly and cooled, it would crystallise well enough, but in crusts or masses, which would be most inconvenient in use. Sugar-candy, which we all know in long sticks of crystals aggregated round threads which are stretched across the pan of syrup, takes a week to form, but we require perfect isolated crystals, and far more rapidly produced. To the astonishment of all scientific men, who are in the habit of considering perfect repose during a prolonged cooling as a condition essential to forming regular crystals, these sugar-crystals (many of which are sufficiently perfect to serve as crystallographic specimens) are produced in the syrup while tumultuously boiling down in the vacuum-pan itself. I was amazed on looking for the first time through the glass-pane in the side of the pan to see the boiling syrup, while tossing and heaving like a foaming yellow sea, full of large regular crystals, often thrown up against the glass to be as quickly washed down again. This agitation renders each crystal independent and perfect all round, with no tendency to adhere into masses. It probably also increases their purity. Faraday found that perfectly colourless and neutral ice could be obtained by partially freezing water mixed with indigo dissolved in sulphuric acid, but only when the liquid was kept stirred with a feather. When the syrup is sufficiently boiled down it is run out of the bottom of the pan just as you see it in this bottle, a pasty mass of these pure white crystals bathed in a somewhat impure and yellow syrup. All this colour has been produced by the boiling, even at the low temperature of the vacuum-pan, for the liquor as it ran in after treatment with the black in a column 20 to 40 feet high was as white and limpid as water, as you see in this sample. The purity and beauty of the crystals will

both depend in great measure on the perfection with which their surface is cleansed from the mother liquor. This is admirably affected by a happy adaptation of centrifugal action, which was patented in 1849 by the late Mr. Finzel. The soft mass, whilst still hot, is thrown into a perforated drum, which is spun round at the rate of about 1,000 revolutions per minute. The liquid syrup is quickly thrown off through the sieve-like sides which retain the crystals in a uniform layer. By watering this once or twice with white liquor every surface of each individual crystal is washed and freed from the last trace of the syrup, and in a few minutes the crystals are scooped out of the machine pure, white, and dry, fit to place that moment on the tea-table or on the grocer's counter. I will show you the process in action on a very small scale with a miniature model from Messrs Manlove and Alliot, the makers of these machines. Here is the mass from the pans, diluted a little, as it is now cold. On working the machine, and after a short interval, "liquoring," as it is called, we take out the crystals white and pure, but somewhat damp for want of adequate time and speed.

The purity of this crystal sugar, as made by Messrs. Finzel, is something marvellous, and difficult to match among artificial products. By Dr. Hassall's analysis it only contains one-tenth per cent. of all matter other than pure cane-sugar, four-fifths of this being a trace of surface moisture. Dr. Cameron found only a two-thousandth part of moisture and ash. My own carefully-conducted analyses give results between these authorities. I find about a twelfth per cent. of foreign matter, mostly snperficial moisture, the ash being only a ten thousandth part. For all practical purposes, we may term Finzel's crystals absolutely pure. We cannot speak with equal confidence of loaf sugar. To manufacture this, the syrup is purposely made to form a small "grain," or imperfect irregular crystals, and the mass is ladled into conical iron moulds set with the point, which is perforated, downward. This aperture is unstopped when the contents have become cold, and the bulk of the liquid drains out. Small portions of white syrup are sprinkled

from time to time on the top, or broad end of the loaf to wash away, as far as possible, the remainder of the treacly liquor. But from the minute size of the grains their surface is very great, and as they are aggregated into a porous mass of the small cells like a sponge, it is almost impossible to obtain in practice such a thorough and perfect cleansing as the centrifugal machine gives to the larger, bold, hard crystals. Hence (the inferior kinds more especially) loaf sugar retains traces of the uncrystallizable impurities and amongst them, doubtless, those nitrogenous ones which cause fermentation. It is true that their absolute weight must be very small, but they are active for mischief. Just as a particle of putrescent matter which can be introduced by the point of a needle or lancet will cause septicæmia or poisoning of the whole blood of a healthy subject, and even destroy life, so a mere trace of a nitrogenised ferment can set up a destructive change in large quantities of vegetable materials such as preserved fruit. Syrup of pure sugar is one of the very best antiseptic or preservative media, alike for animal or vegetable substances, but it must be pure. Brown sugar used in preserving fruit will cause abundance of frothy scum, and the jam will afterwards be apt to ferment and spoil. The inferior kinds of loaf sugar produce the same effect, though in a lesser degree, while the pure crystal sugars are practically found to give greater economy at starting, from the high sweeting power, and far more permanence in keeping. Moreover the bulk of the lump sugar now offered in the shops is made abroad, chiefly by the French, and sold to us at a much lower price than in their own markets. This is made from a mixture of cane and beet-root sugars, and some of it, and also of foreign crystals which I have met with, smelt when dissolved in warm water, like the bilge-water of a ship. To sum up my experience, and speaking merely as a scientific man, without any personal bias, I emphatically say that I consider that crystals like those on the table should entirely replace the old-fashioned loaf sugar. Some object to the slower solubility of the bold crystals which are so popular and largely consumed in the manufacturing districts of England and Ireland.

To meet this objection, Messrs. Finzel have lately introduced a new a new make, equally pure and beautiful, but considerably smaller in the crystal. This dissolves nearly as quickly as lump sugar, and is specially intended for the London market.

I must ask you to bear with me yet a few minutes while we throw on the screen some photographs, also kindly lent me by Professor Gardner. In the decayed and stagnant old town of Bristol there is one object of interest, the gigantic Counterslip Refinery of Messrs. Finzel, the most extensive in the kingdom, producing annually about sixty thousand tons of sugar, a large proportion being of the finest kinds. The packages of raw sugar are hoisted to the top floor, that the syrup may descend by gravitation alone, as far as possible, through all the operations. It is first dissolved by a happy application of the vacuum principle (also patented by Mr. Finzel), carefully strained and passed through tall iron cylinders filled with granular bone-black, from which it runs as white and clear as water, thanks to the invaluable absorbent power of the black. Here is a bottle of the raw syrup after the mere straining, dark coloured, in mass almost opaque; here the same liquor after the action of the charcoal. It is then ready to boil down in the vacuum-pans, for no trace of chemicals, lime, blood, or any foreign substance whatever is used in making these crystals. Fine raw sugars, water to dissolve, and black to decolorise them, are the only materials employed. The crystal pans are smaller than the one of which I showed you a photograph some time ago, and are set on a raised platform like the quarter-deck of a man-of-war, and almost as scrupulously clean. Steam, which hoists the sugar and then dissolves it, boils the syrup in the vacuum pans, and works the huge pumps which exhaust them, plays a large part in all refinery work, and the chief boiler-house is a wonderful sight. Sixteen great boilers, each 35 feet in length, are ranged in long perspective, the coal which they consume being transferred direct into their fires from barges in the floating harbour outside. Here is a view of the centrifugal machines; but, of course, it only shows their outward aspects, the perforated drum being inside. The crystals from the different boilings are

not absolutely uniform in size or whiteness, and require to be mixed to a general standard. They are conveyed in large zinc pans on wheels to the "mixing-room," from the upper stage of which they are shot down into heaps on the floor below, where they are tossed backward and forward till uniformly mingled. There are often four to five hundred tons of the crystals thus piled up in mounds (the place will hold 1,000 tons), and this may all disappear in a couple of days unless replaced. Standing among these banks of pure, white, glittering crystals, one may fancy oneself transported into Alpine scenes of snow and ice, and on a bright day the glare is almost trying to the sight. There are numerous atmospheric bells overhead, each numbered, and when one is rung from the basement below, a corresponding trap in the floor is opened, and the crystals are quickly shovelled down its shoot into a cask placed beneath, to issue forth to the consumer a beautiful and a perfect product.

I must not add a single word, except to thank you for the patient kindness with which you have borne this lengthy and imperfect paper.

DISCUSSION.

THE CHAIRMAN said there was scarcely time to enter on a full discussion of the many subjects introduced by the reader of the paper; for instance, the optical test for sugar, which was of immense importance, and the question of impurities and adulteration. But is occurred to him that as there were several gentlemen present who were practically acquainted with this subject, it would be as well if they would direct their attention to two or three points of prime interest. To begin with, he thought it of great importance that they should consider what might be termed the practical value of the particular process now brought forward. They had not had an opportunity of going into the details of this method, which would have been very interesting, or considering the influnces of particular impurities with regard to the quality of the product. They might also direct their attention to another important question, viz., what was the particular sugar in comparison with

that which had been in ordinary use for ages past? No doubt the fact of its being pure in respect of its crystalline form was a great advantage, but he should like to know from those conversant with the subject whether there was really any chemical difference between ordinary lump sugar and the crystals on the table. Probably an analysis of the two would give some idea of the respective chemical properties of those two sugars, and that was a subject which he thought might be very advantageously discussed, so as to give the reader of the paper an opportunity of saying what were the absolute values respectively of the old-fashioned lump sugar and of the crystals. The two points suggested for discussion were shortly these—what was their value as determined by investigation in the laboratory, and as determined by their practical use?

Mr. W. EATHONRE GILL said he had not quite gathered what was the difference between the manufacture of this crystalline sugar and ordinary lump, except in the use of the centrifugal machine. If there was anything beyond he should be glad to hear of it. As to the relative solubility, that was probably accounted for by the fact that there were more surfaces in the small crystals than in the larger exposed to the liquid in which it was immersed.

Mr. JOHN NEWLAND remarked that the photograph which had been thrown on the screen of the very disagreeable-looking insect described as being prevalent in many varieties of sugar would be very likely to alarm a great many persons, and he should like to know whether that animal was met with only in cane sugar, or whether it was also present in beet-root sugar. If persons had any objection to consuming sugar which had been in any way mixed up with insects of such a peculiarly disgusting character, and it was found on examination that this objection did not apply to any particular class of sugar, it would probably lead to that sort of sugar being used in preference. He would also ask whether it was not the custom of scientific analysts, and those who manufactured sugar of whatever description, to continually taste different samples, and whether they would in this way introduce large quantities of these insects into their system from time to time.

Therefore if they did so with comparative safety to themselves and arrived at a good old age, he wished to know what was the practical value of frightening the public by calling attention to such matters.

Mr. McCOMBER would like to know the difference in the saccharine matter contained in 1 lb. of these fine crystals, as compared with the moist sugar sold in the market, in order that the difference might be recognised otherwise than by the taste. He had often heard the crystals objected to on the ground that they dissolved slowly.

Mr. BRAMWELL, C.E., said it would have been more satisfactory if Dr. Griffin had stated the exact amount of impurity in good ordinary loaf sugar. He had given the percentage of impurity in the crystalline as made by Messrs. Finzel as a very small fraction per cent., but when he came to speak of loaf sugar he only stated the impurities must be more, but how much more he did not state. It appeared to him that the difference between this mode of manufacture and that of loaf sugar was that there was a peculiar method of boiling, which ensured a large grain and therefore gave less amount of surface, so that when the faces of the crystals were washed in the centrifugal machine there were less surfaces in proportion to the weight; and it would be probably more easy to wash those faces than the greater surfaces of the small crystals when put into the mould in the ordinary method. After all, the crystals themselves must be equally pure, whether large or small, and it really was a question of getting the surfaces clean. Then came the question how far were the surfaces left dirty in the ordinary washing in the mould, where the cleansing was effected by the percolation of white liquid through them, a considerable time being occupied in the operation. There the liquid washed the crystals by the action of gravity, while in the contrifugal machine the motion was greatly intensified, and the liquid which washed the faces passed through the crystals at a greater rate owing to the centrifugal action. It might be interesting to the meeting to know that the engineer to whom many years ago he himself was apprenticed invented and largely practised a mode of intensifying

the action of gravity in sugar refining prior to the introduction of the centrifugal machine. His method was to put the whole production of the vaccum-pan on a fine stationary sieve some inches thick, and level it. Then a kind of vacuum was formed underneath, and the surface being wetted, either with the appropriate syrup or with water, the pressure of the air drove this syrup through the crystals and washed their faces in the same way as in the centrifugal machine, leaving the white crystal on the top of the sieve. This process was largely used in the colonies for some time, until it was checked by the Customs' regulations, which imposed a new duty, according to which at that time the duty varied with the degree of purity, and when this white sugar came to England it was called refined sugar, and charged a heavier duty. This showed that the making of granulated sugar and the washing of crystals by rapid action was not a novelty, having been practised very successfully many years ago. He was rather struck by a statement in the paper which did not quite agree with the somewhat extensive experience he had had lately amongst some of the largest sugar manufactories in the world, with regard to sugar-cane yielding 90 per cent. of juice, and leaving only 10 per cent. of woody matter. As a matter of fact, with the best machinery and average canes the percentage of juice was as nearly as possible only 66 per cent. Dr. Griffin had also stated that one horse power would yield 100 gallons of juice in an hour. He had tried very many engines when taking the quantities ground by the mills, and the very best results he ever obtained were four indicated horse power and a fraction for a ton of canes per hour, and to grind 18 tons of cane in an hour it required very nearly 80 gross indicated horse power. He had found an instance, where the men had been trying to make exaggerated results for his satisfaction, that they had got up as high as 12 indicated horse power, because they were working the mills unfairly, but when a steam engine indicator was put on it was very apt to tell the truth; therefore taking it at the best it would be found that instead of 100 gallons per horse power it would be more nearly 36. The only way he could accout for this discrepancy was by supposing that Dr. Griffin had taken the

nominal or commercial horse power, whilst he (Mr. Bramwell) took the indicated horse power on the piston, which varied from two to four times the nominal.

The CHAIRMAN asked if Mr. Newlands could state the amount of impurities present in loaf sugar.

Mr. NEWLANDS said he had no pretensions to be a scientific authority on this subject, as his experience had not been particularly directed to the question of loaf sugar. Every one, however, knew perfectly well that in good samples the percentage of impurity was very slight, something like 1 or 2 per cent. He should not like, however, to pledge himself to the absolute amount of moisture or nitrogenous matter.

The CHAIRMAN said he understood the result of Mr. Newlands' experiences was that in 100 parts of loaf sugar there were 98·8 or 98·9 parts of pure sugar, the remainder being impurities, including moisture and mineral matter.

Mr. NEWLANDS said that was so, but his experience had been rather limited.

The CHAIRMAN said he should like Dr. Griffin to state what percentage of the *masse cuite* was got in the form of these crystals, and, in the next place, whether the residuum or drainage presented greater or less difficulty in subsequent treatment than the drainage from ordinary loaf sugar—in point of fact, what qualities and characters of sugar were produced from the residuum; because it appeared to him of considerable importance to consider first whether there was a larger or smaller proportion of crystals obtained than under the ordinary process, and next whether a better or worse product was obtained in the subsequent treatment of the syrup which ran from these crystals than would be obtained from the drainings of ordinary loaf sugar. He did not quite understand either whether the crystals were washed in the centrifugal apparatus with ordinary water or with syrup, and this would to a large extent affect the expense as well the character of the subsequent treatment of those syrups. Again, it seemed to him a matter of considerable practical importance how the syrup was evaported in the vacum-pan, whether the crystals were produced

largely in the pan, or whether by subsequent cooling or heating they were developed after withdrawal, and also whether in the conduct of the process the charge was entirely withdrawn from the vacuum-pan, or whether a portion was left as a sort of nucleus for the deposit of crystals in the subsequent treatment. He should also like to know the proportion of impurity in ordinary brown sugar as compared with that present in these crystals.

Dr. Griffin, in reply, said the most important question which had been put was as to the absolute amount of impurity present in loaf sugar. This varied very greatly, and ranged, he believed, from about 2 per cent. in the lowest samples to about ·5 per cent., or possibly in very fine samples ·25. It was not, however, so much the absolute quantity as the character which must be considered. With regard to this, chemistry and the balance were at fault, and until they could weigh that matter, which unquestionably would produce epidemic disease, they could not always estimate the total value of impurities by their absolute weight. Their nature eluded observation, but they knew from experience that the only way to arrive at a conclusion was experimentally, that where these traces of nitrogenous impurity remained they would set up fermentation, whilst if the substance were chemically pure this would not occur, so that if the amount was apparently small the effects might be very mischievous. The question as to practical sugar refining he could not answer satisfactorily, as he spoke only as a chemist and not as a sugar refiner. In the first place the entire building up of the sugar crystals took place in the pan itself, for after a very short cooling, on removal from the pan, the *masse cuite* was conveyed to the centrifugal machine to be there separated. The growth of the crystals undoubtedly took place in the pan, though this was a most extraordinary fact both to himself and scientific men generally. With regard to the nature of the residue he could only say that it might be entirely worked up into comparatively fine sugar, and this large refinery could be carried on if desired year after year, without the production of any molasses, or any low class of sugar whatever. With regard to the amount of sap and woody fibre contained in the cane there was no doubt that Mr. Bramwell, speaking from ex-

perience, was quite correct, because it was notorious that a very large amount of juice and also of valuable sugar was left in the canes, he believed fully 25 per cent. was wasted. He had referred in the paper to the theoretical quantity as determined by exact analysis, not the amount yielded in practice. Another gentleman had inquired whether those in the habit of tasting raw sugar did not swallow these acara to which he had referred; he could not answer for all his brethren, but for himself he could say he never did, for he had such a horror of those lively gentry, that he did not care to introduce them into his own system. He believed they were not found in beet-root sugar, at any rate he had never found them there himself; and he believed that the offensive oil which he had referred to as being present in beet-root was too much for them; and no one would ever dream of using raw beet-sugar as an article of food. As had been stated by one of the speakers, the difference between this crystalline sugar and ordinary lump was simply in the use of the centrifugal machine. The substance of the crystals was beyond question pure, whether they were small or large, and the impurities were simply on the surface. Therefore, when loaf sugars were abundantly washed, no doubt they might be rendered fine and pure enough; but the bulk of the loaf sugar offered in commerce was very far from being so, much of the French sugar being almost a solid compact mass. The only way of comparing different classes of sugar and the amount of nitrogenous matters contained in them, which would induce chemical changes in the blood or in vegetable matter, as, for instance, in preserved fruit, was not by means of chemical tests or the balance—because the whole might be imponderable—but by carefully trying the substances against each other, and then if it were found that one slightly impure substance set up fermentation, and the same when perfectly purified did not, a practical solution would be arrived at.

Mr. BRAMWELL asked whether the sugars made from the residuum of the first crystals contained more or less nitrogenous matters than ordinary loaf sugar? If they contain more they must be more impure.

Dr. GRIFFIN said no doubt the pieces made from the residuum of

the crystals must contain far more nitrogenous matter than the worst loaf sugar, and they were sold as an article of food. Of course, all moist sugar, or pieces, as it was technically termed, was fermentable, and all contained traces of nitrogenous matter.

The CHAIRMAN then proposed a vote of thanks to Dr. Griffin, which was carried unanimously.

ANALYSIS OF ANIMAL CHARCOAL (BONE-BLACK).

BY G. COMBE STEWART, F.C.S., Greenock.

From the *Chemical News*.

The importance of the study of chemistry is now generally acknowledged; besides the various observations in Nature which excite curiosity the experimental method furnishes one of the most salutary exercises for the mind, constituting in this respect a fitting supplement to the study of the mathematical sciences.

The method of deduction in these, while eminently adapted to form the habit of strict reasoning, scarcely affords any exercise for the critical faculty, which plays so important a part in chemical science.

In the many branches in which chemistry is applied to this art, that section which treats of the analysis and manipulation of animal charcoal is the most important. The chemical analysis of animal charcoal forms the foundation plate of success in working it in that great laboratory, the sugar refinery. In it all the work done should be conducted on chemical principle, and no sugar-refiner who works contrary should expect too much from any sample of charcoal, because there is no substance in which he is more apt to be deceived than the treatment of this material on any other principle than that of modern scientific basis.

Charcoal to the eye may exhibit satisfactory properties and yet be totally useless for sugar refining; yet, notwithstanding this fact, some merchants expect the same work from it as from a genuine sample. If the charcoal does not possess chemical properties which are characteristic of the finest bone-b'ack, how can a sugar-refiner

hope to take it out of it in the face of chemical facts? No; facts are facts—natural philosophy follows.

Knowing, then, that the proximate analysis of animal charcoal is of the highest importance, the following general process and remarks will be found very suitable in effecting such.

In determining the moisture, carbon, and total organic matter, a weighed portion of the charcoal may either be submitted to direct combustion in a suitable furnace, collecting the products in the usual manner, or the moisture may be determined by drying a weighed quantity in the hot-air chamber at a temperature of 160° to 180° C. for six hours. The loss in weight is moisture, and on ignition of the residue it will supply the sum of the carbon and organic matter. In careful hands both processes are excellent, and should correspond with each other, remembering the fact that charcoal when ignited the loss in weight is equal to the sum of the moisture + carbon, + total organic matter.

Should it be desired to determine the carbon by the *solution* method, viz., treatment with hydric chloride, the carbon is obtained insoluble, mixed up with the siliceous matter, which can be separated by direct ignition. Particular attention must, however, be bestowed to this carbonaceous residue in determining the carbon by this method. I have found considerable difficulty in washing it free from hydric cholride, and in drying it so as to obtain the siliceous matter with accuracy on ignition.

By attaching to the filtering apparatus a suction-pump (such as is described on page 61 of Dr. Thorpe's "Quantitative Chemical Analysis") the residue may be obtained in a very superior manner and leaves nothing to be desired. It should be dried at 160° to 180° C. in the hot air chamber, and then weighed. The practice of drying this residue at 100° C. instead of 160° to 180° C. is in my opinion a mistake. I hold the same views with respect in determining the moisture at water-bath heat.

Were the latter assertion true, we should obtain on direct ignition, after the treatment in the water-bath, a result something like 4 to 5 per cent of organic matter in every sample of charcol which we had occasion to analyse; but no charcoal contains this amount of organic matter (exceptional instances overlooked).

The oxide of iron, which is very constant in amount in new and old char, is best determined volumetrically by dilute standard solution of the potassic anhydro-chromate (Penny's process), or better by dilute standard solution of the potassic permanganate, using 0·5 grm. $KMnO_4$ in 1 litre distilled water; and the phosphoric acid may be determined with advantage by using a standard solution of uranium nitrate or acetate. Should chlorine be detected in any appreciable amount it is best determined volumetrically by standard solution of argentic nitrate and neutral chromate of potassium.

With regard to the moisture in new char, sugar refiners are perfectly aware of its presence. The amount fluctuates between 5 and 10 per cent (dried at 160° to 180° C.), sometimes being as high as 15 per cent, and one sample which I had occasion to analyse, the mean of twelve experiments, yielded the enormous result of 20·42 per cent of useless water. True such char is sold at a reduction in price, but I hold that new charcol can be manufactured without this useless water, but probably at an increase in cost. The fact is the days of these deceptions are numbered, and, in a scientific age, the sooner intelligent sugar refiners demand their char with a reasonable amount of moisture in it (say 2 per cent) the better for all parties.

With regard to the organic matter in new charcoal, I have been particular and exact in determining this constituent in many samples of animal charcoal which I have had occasion to analyse. Indeed, the importance of the work usually entrusted to me will not allow me to overlook its presence, and, as the result of my examination, I have found it to fluctuate between 0·01 and 0·5 per cent; never more in new charcoal, and in the stock char of sugar refineries, where soft water is used, it is frequently as low as 0·001 per cent, and even this is only detected after grinding the charcoal to absolute dust. In regard to these figures I believe I have the coincidence of chemists, bone-char makers, and sugar-refiners, who really possess a considerable amount of authority on the subject.

The presence of this organic matter is a source of great annoyance to modern sugar-refiners. A portion of it dissolves in water and in acid, while the remainder is totally insoluble in either menstruum. It may be detected by the following tests:—

(*a*). Heat some of the dry char in a dry test-tube, inhale the fumes; should they smell of burning organic matter the inference is clear as to its origin.

(*b*). Separate all the matter soluble in distilled water, evaporate the solution in a platinum basin, raise the temperature; should the residue *blacken* it proves that the carbonaceous matter is in an incipient state of combustion. Soluble organic matter is indicated.

(*c*). Place some of the char on a watch-glass, underneath which is a circle of filter paper, run some strong dihydric sulphate over it. Blackening indicates the presence of organic matter.

(*d*). Filter the acid through asbestos previously washed with the same acid, should a very dark liquor filter through.

(*e*). If a portion of the charcoal be boiled with solution of caustic soda, and a yellow or brown solution is obtained, the presence of organic matter may be inferred.

Charcoal when new frequently contains considerable quantities of caustic lime and many other small constituents, which should on no account be omitted; and in all cases qualitative analysis, should be resorted to previous to trying quantitative analysis, and even microscopy will perhaps lead to the discovery of substances entirely foreign to new animal charcoal, such as common coal, road sweepings, old charcoal from sugar refineries, associated with old charcoal dust and many other things.

Following up these adulterations it is the duty of the chemist to detect and estimate them if possible, and at all events to clearly prove they exist there.

(1). To commence with the detection of common coal in presence of animal charcoal. This may be detected with advantage by aid of microscopy, comparing the effect with standard coal and bone-black respectively, or with absolute certainty by the following ignition test. Place some of the suspected char in a platinum crucible with the lid on (a porcelain crucible is more preferable), heat somewhat strongly, and observe your subject.

(a) Volatile matter is given off.

(b) Which enters into rapid combustion.

(c) And burns with a yellow smoky flame.

(e) Leaves a carbonaceous deposit on the inside of the lid.

(f) The residue may *cake*.

(2.) Road sweepings may also be detected by the appearance of the charcoal under an ordinary microscope.

(3). The adulteration of old charcoal with new, of which the former, which is absolutely useless for sugar refining purposes, and old charcoal dust, may be detected by the assistance of microscopy, or in the case of char dust by mechanical analysis and chemical combined.

Place some of the suspected char on a series of wire gauze sieves, such as are frequently used in sugar refineries in testing the division of charcoal, allow the dust to fall to the bottom of the apparatus, make a chemical analysis of both the charcoals, and ascertain their composition. This test is peculiar, because new animal charcoal and old spent material differ widely in their chemical composition, as also in their properties. The amount of carbon, water, iron, and alkaline salts, and organic matter are very constant in proportion in their respective samples, and tell at once whether the chars are identical. Thus new char does not contain more than 0·15 per cent of oxide of iron, whereas old charcoal contains as much as 0·30 per cent, and sometimes as high as 0·60 per cent. Again, the ash which a char leaves on ignition is a good indication of its age; thus new animal charcoal when genuine leaves a pure white ash; whereas old charcoal when ignited leaves a yellow or brownish ash, frequently cream coloured; and also the appearance of old and new char under a microscope can be distinctly distinguished. New charcoal is regular in division, and sharp round its edges, and black and velvety in appearance. Whereas old charcoal, from frequent revivification and manipulation in the sugar refinery, is confused and scattered in division, and broken and coarse round its edges, and has the appearance of time-worn stones. By these latter properties under the microscope it is easy to tell whether charcoal is mixed with old or stock char.

In working out these detections by means of the microscope the process will be highly facilitated by the help of the standard. The presence of these frauds in animal charcoal is nothing new in connection with sugar refining, and I should only be too glad to add to

my stock of information, so as to hold a position of advantage to detect and suppress them.

With regard to the amount of burning a charcoal should receive to meet the views of sugar-refiners, new foreign charcoal is often over-burned, whereas home-made is as often under-burned; of both evils, the charcoal which is under-burned to a certain point, but not further, is to be preferred. Now when charcoal is over-burned the carbonaceous matter reacting on the calcic phosphate evolves free phosphorus; but in sugar refining, where upright revivifiers are employed, this seldom happens, the temperature being such as only to produce agglutination.

In sugar refining, where many samples of animal charcoal have to be examined to test revivification, it is indispensable that the method of bringing these samples to a rapid and also a very delicate test is of the highest importance both to sugar-refiners and also to chemists.

Having had frequently to keep pace with the revivifiers in a sugar refinery, I have found it an excellent test to find whether a specified char contains organic matter or not; if so the revivification process is scarcely complete, and should be repeated. The most delicate test which I know of, and which can be employed by any intelligent sugar-refiner, is—Place a *piece* of the charcoal under examination on the glass side of a microscope and cover it with a *drop* of pure strong dihydric sulphate, allow it to stand for a short time, and then observe the effect through the microscope. Should organic matter exist in the char, even in the minutest trace, it will colour the acid brown, and the deeper in proportion. Many samples from the revivifiers may be tested in this way during a day.

These are facts in connection with the analysis and treatment of animal charcoal which are of the highest importance to chemists, and also to sugar-refiners who conduct their business on chemical principle, and are the observations of researches conducted for three consecutive years on the study of animal charcoal, both in the laboratory and in actual practice in the sugar refinery.

And, in conclusion, I regret that gentlemen connected with the Clyde sugar refineries, and elsewhere, rarely give scientific journals the benefit of their enlarged experience; still should any

interested parties take up the subject for study, they will find it to be an endless band of chemical facts; the more it is studied the more curious it is to understand; and moreover, science has not yet grappled the difficulties which are to be met with in its treatment on a large scale in actual practice.

Extract of Letter received from Mr. W. Atkinson, Isipingo, Durban, Natal, Dated Jan. 6th, 1874.

"I have pleasure in expressing my approval of the working of the trays; up to this time I have made between 30 and 40 tons of sugar from green Natal cane, density 10½° B., and have obtained 1 lb. 6 oz. of sugar per gallon of juice, or 6 oz. per gallon more than I probably should have got without the trays, and this under rather unfavourable circumstances. I hope to obtain a better result than this yet. * * * * I have to say that I am glad I ordered the trays, and am perfectly satisfied with their work. I am not prepared to say that the whole Concretor apparatus would not be better than the trays alone, especially as Mr. Platt informs me that from similar cane to mine he has recently got 1¾ lbs. per gallon of juice, dens. 10½°, the sugar selling at good prices, the lowest quality at 22/6, and the best at 25/- per cwt.; also from the inferior China cane he has been getting 1½ lbs. good sugar per gallon of juice.

Note.—Mr. Atkinson is working with a set of Concretor trays, and Mr. Platt with a complete Concretor for concentrating the juice. The finishing is in each case conducted in the Wetzel pan.

IMPROVEMENTS IN SUGAR MAKING.

The methods of purification employed in sugar industry depend almost entirely upon the action of lime and the elimination of that alkali by carbonic acid. These processes leave remaining in the saccharine products a certain proportion of organic matters and mineral salts which oppose to a certain degree the crystallization of the sugar, while also causing the formation of molasses

and the mingling of the sugar with the residue. M. P. Lagrange has recently devised a method which is based on the elimination by the joint action of baryta and phosphate of ammonia of the organic salts of lime, of certain vegetable acids combined with potash and soda and of the alkaline sulphates existing in the sugar products. By this process, without the aid of lime or salts of lime, and while causing the eliminations as above noted, M. Legrange believes that he is enabled to produce the products and to secure the best conditions of alkalinity without forming glucose at the expense of crystallizable sugar. In factories, therefore, devoted to the manufacture of cane sugar, it would seem that this improvement is of considerable importance in doing away with the serious difficulties and large losses due to the glucose formation and the lime salts.

The purifying process generally in sugar manufactories is applied to syrups of 20° Beaumé which have already been submitted to the calco-carbonic treatment. The products being led into a serpentine or double bottomed boiler, phosphate of ammonia is introduced in proportion to the lime, of which the quantity has been determined by hydrometric analysis, so as to leave in the syrups but a thousandth part of lime absorbable by the black; then the baryta is added in such proportion to the sulphates and organic matters that the syrups will eventually contain but one hundredth part of matters still precipitable by that substance. The whole is then boiled, filtercd, and carried to the coarse black, leaving in the receptacles a residue which constitutes a most valuable fertilizer.

In refineries where the purification is made in the boiler where the crude sugar is melted, dissolved phosphate of ammonia is substituted for fine black and blood in such proportion to the lime as to leave a hundredth part of the alkali which the black totally absorbs; the baryta solution is next added in such proportion to the alkaline sulphates and organic matters contained so that only the quantity of alkali necessary for the easy maintenance of the alkalinity up to the molasses will remain. To obtain the best reaults, experience has proved that for a sample of sugar indicating 88° the proportion of phosphate of ammonia crystallized

per 2,200 lbs. of sugar is 1·6 lbs. and that of the baryta per same weight of sugar is 6·6 lbs. using the hydrate of 10 equivalents of water.

The mixture, after melting, is boiled, when the precipitate swells and a clarification ensues comparable to that obtained with blood albumen. The syrup is then treated as in the instance already cited, and the residue from the filters is also applicable to fertilizing purposes. The products of establishments using the process are said to be largely increased.

In connection with the subject of sugar manufacture may be noted an important invention recently patented by M. Marguerite (represented in this country by Mr. Edmund Ratisbonne, 48, Broadway, New York City) through this office, for obtaining sugar from molasses by the addition to the latter of certain salts which provoke crystallization. The process is said to be especially valuable in treating third quality syrups as well as molasses. The operation consists in adding to the spent molasses (containing say 50 per cent. of sugar, 15 per cent. of salts, and 20 per cent. of water) crystallized sulphate of magnesia in the proportion of 20 per cent. by weight, together with a little water to make a solution of the sulphate marking 100° Beaumé. The whole is then subjected to centrifugal action in a machine having either perforated sides or very fine wire cloth. The sulphates of lime and potash precipitated are retained and the liquor is then filtered through charcoal and boiled in vacuo. After cooling a certain quantity of pounded sugar is added to form *nuclei* and the syrup is lastly subjected to the ordinary temperature of Fehlings, the heat being alternately raised and lowered.

After a few days' crystallization becomes exceedingly abundant and continues to increase for some time, after which, the hydro-extractor is employed. Other salts, such as sulphate of soda, sulphate and chloride of magnesium, chloride of manganese, sulphate of iron and zinc and their chlorides, and also the acetates, nitrates, and ammonia salts, though these are not so desirable, may all be used instead of the sulphate of magnesia, the proportions of which vary according to the nature of the molasses and the results of expense. The crystallization of the sugar results from

elimination of the potash, the salts of which are prejudicial, its place being taken by the magnesia, whose salts are favourable thereto.

This invention we believe to be one of considerable importance in an economical point of view, and hence perhaps worthy of the closer examination of sugar manufacturers generally.—*Scientific American.*

SUGAR STATISTICS.

TO THE EDITOR OF THE "PRODUCE MARKETS' REVIEW."

SIR,

The question of Sugar Statistics brought forward in your last week's number is, doubtless, of great importance to the trade, and demands immediate solution. Confusion once entered upon will not easily be rectified; and the mischief may be said to have already begun, as by the time this appears cargoes of sugar will have commenced to be stowed away in free warehouses, of the existence of which no one will be cognizant except the owner. I do not think any difficulty will be experienced so far as imports and exports are concerned, and therefore I will not enter upon that branch of the subject, but confine myself to the point of deliveries for home consumption, accurate returns of which, I presume, can only be obtained for the future by the voluntary co-operation of those who constitute the medium of passing into consumption.

There are two classes of sugar to be dealt with, the consumption of which I will call respectively "indirect" and "direct:" the former consisting of what passes through the process of refining after landing, and the latter, whether refined or raw, which goes into consumption without such further process. A point must be established with regard to both of these, as to when they are to be taken as passing into consumption, having lost the one they have hitherto had in common—namely, the payment of the duty.

With regard to indirect sugar, I presume the point fixed would be its melting in the refinery. Every refiner knows how much he melts each week. All that would be necessary, therefore, would

be to procure a confidential return, weekly, from every refiner in the United Kingdom, and a quarter fixed for the reception and publication of these returns in the aggregate. With regard to "direct" sugar, however, it is not so simple; but, as many are of opinion that this "direct" sugar is likely to increase beyond even its present formidable proportions, it is important that some principle should be found at the outset, which, in practice, would be sufficiently accurate and yet not too cumbersome. I am inclined to think, although it might not be quite satisfactory, that the only practicable method as regards that portion of "direct" sugar which comes under the description of stoved goods, would be to adopt landing as passing into consumption. The lots come into so many hands, and in many instances are so small, that I fear any attempt to procure further returns would prove inoperative. Besides, they are not a class of goods which anyone is likely to hold a very large stock of, and may be said to occupy a similar position to the stock of their own manufactured goods held by the refiners.

It only remains to consider the other portions of "direct" sugars—grocery raws and crystals. There is no doubt that here is the greatest difficulty; but it can only be dealt with in a broad way, and by procuring the co-operation of such wholesale grocers and dealers as is necessary, and who might be invited to send in weekly returns similar to the refiners, making the point of passing into consumption the transfer by sale to parties not sending in returns. It seems to me that too much time has already passed by, and as the speediest way of bringing the matter to a practical bearing, I would suggest, if he will pardon me the liberty, to Mr. G. Martineau, to propose in your next number, by your permission, the names of a Committee of the United Kingdom, to arrange and carry out the necessary details.

I am, &c.,

THOMAS O. EASTON.

34, Moorfields, Liverpool, 28th April, 1874.

*** Our correspondent does not deal with the question of how the returns of the stocks are to be obtained. In London there would be no difficulty in obtaining these for raw and foreign

refined sugar from the public warehouse-keepers, but one of our chief refiners, we believe, imports sugar direct into his refinery, and this is a general practice at other ports. The refiners, therefore, who import direct would have to return their stocks of raw sugar. It would be invaluable if the undelivered stock of made sugar in the refineries of the kingdom could be ascertained as well as the stock of raws. The whole of this subject of the collection of Sugar Statistics under the new order of things is beset with the greatest difficulties, and it is not easy to see how they are to be met.—*Ed. P. M. R.*

SIR,

Allow me to supplement my last week's letter on Sugar Statistics, which, as you observe, did not directly deal with the question of how the returns of stocks are to be obtained. But it dealt with the element which appears to me to present the greatest difficulties—namely, the deliveries for consumption. I would propose that the returns should be made up on the same principle as formerly—that is, that to the given stock of sugar in the country the landings for the week should be added, and the deliveries deducted, the balance being taken as the new stock. We are, fortunately, at no loss for the quantity of stock as a starting-point, taking the figures supplied to us by the Customs as being in bond on the 30th ultimo.

If some such plan as I suggested in my last be adopted with regard to deliveries, it only remains to get at the landings. I hazarded the remark in my last that I did not anticipate any difficulty with regard to this. Perhaps I was a little rash ; but the most obvious way seems to me to be still through the Customs. No sugar, even when free of duty, can be landed without a Customs' entry, with a declaration of the weight. The refiners whom you allude to as importing direct must pass an entry, and must declare the weight ; and I am confident that if the importance of the matter is properly represented to the Customs' authorities, they will take steps to procure the weight as accurately as possible, and publish weekly returns, in the form most convenient to the trade. Such, I find, is the opinion of the Collector

of Customs here, so far as regards this port, and he knows of no reason why it should be any more difficult at other ports.

I quite agree with you that the question is beset with difficulties, but not, I hope, insurmountable ones, always provided that the trade values statistics sufficiently to take a little trouble to procure them; and although, of course, we cannot look for the perfect accuracy of the former returns, that is no reason why we should not avail ourselves of the best that can be got. By and by, no doubt, grave errors may creep into the figures, and a system must be devised for periodical stock-takings, through warehouse-keepers, &c., in order to check the theoretical stock with the actual; but that is not the difficulty of the hour, and I am only anxious that the immense advantage of the starting-point of the fixed stock of 30th April should not be lost through delay in inaugurating a system.

I am, &c.,

Thomas O. Easton.

Liverpool, May 6th, 1874.

VALUATION OF THE PRODUCE AND LOSS IN THE MANTFACTURE OF SUGAR.

By M. Ed. Riffard.

I desire to correct in these few lines, an error which I was not long of noticing myself, and which has been pointed out to me by the attention of chemists and manufacturers.

The point upon which it bears, and the consequences which are attached to the question, required on my part a prompt rectification, which I would have been glad to submit to professors if time had allowed me.

I said that the volume of water of condensation coming from the "*triple effet*" and "*a cuire*" apparatus might be estimated at 5,000 hect. per day, and that the average yield of sugar would be from 2·055 gr. per litre, corresponding to a total loss (there lies the error) of 688·43 kils. of sugar, being 0·0028 gr. per 100 kils of beetroot.

The total loss as a simple calculation shows, is a hundred times too great, that is to say 68·843 kils., corresponding to 0·2867 per 100 of worked beets.

The volume of total juice authenticated
by the Excise being 213·411 hect.
That of "*masse cuite*" and molasses.. 28·566 ,,

The difference 184·845

represents pretty nearly the water expelled by evaporation during 67 days work, being about per day 2·750 hect.

Taking into account as water added for
condensation of these vapours 2·250
It follows that there has been thrown
out 5·000

of water containing 2·055 gr. sugar per litre, being 1·027·5 kils. per day, or for 5·000 hect. of water going away; which gives for the whole season, representing 67 days work, 68·843 kils.

It is found that the table of produce and loss will be thus modified:—

PRODUCE AND LOSS.

		Kils.	Per cent. of Beetroot.
Contents	Juice.....	1,767,256·5	7·3635
	Pulp.....	259,278	1·0803
		2,026,534·5	8·4438
Sugar Lost.	Pulp	259,278	1·0803
	Scum	45,902	0·1912
	Filters	15,778	0·0656
	Evaporation	68,843	0·2867
	Molasses	452,793	1·8866
	Charcoal, &c.	40,619·5	0·1696
		883,213·5	3·6800
	Extracted.....	1,143,321	4·7638
		2,026,534·5	8·4438

By this correction it is seen that a one hundredth only of the weight of sugar for 100 of beet should be placed amongst the losses partial and so numerous in a refinery: wear and tear of stock, errors of weight, of volume, etc., etc.

For this same reason it clearly shows, at least in our case, that after the molasses and pulp, it is the evaporation that causes the most considerable loss in sugar. Several very competent manufacturers and chemists estimate, and it is also my own observation, that this loss takes place altogether in evaporation of the juice, and that it ought to be much less sensible in the "*cuite.*"

It would be desirable in the interest of our fine industry that in manufactories researches of this kind should be proceeded with, which, besides, require more care and ability than laborious working.

Let us not forget that the field of improvements of which a sugar refinery is susceptible is still very wide. The mechanical part has progressed above all just now; we are indebted to it for new and economical institutions, principally in the preparation of juice and its concentration. It is for us manufacturers and chemists, who profit every day by these changes, to add to them by the advantages we have by carefully studying the operations of the factory; it is this which will enable us to find out the weak points and prevent loss.

Bearing amongst themselves the unchangable relations which the necessities of the sugar industry are drawing still closer at this critical moment, the mechanic and the chemist should indulge in a mutual intercourse if we wish to obtain from the conjuction of these two forces durable and advantageous results.

From all these points of view, in one word, let us enter freely into this view of research; let us banish far from us this deplorable routine, the rock and barrier to all progress, in order to sustain the struggle into which vain financial combinations have forced, with unpardonable imprudence, the sugar industry of our country to enter.

Forced to submit to these hard trials, in meeting which, the most able hands will bring us back to better days, let us bring round us, at least, all the methods capable of lightening this burden. In the number of these methods there is classed quite naturally, that of the amelioration in the produce of the *sucrerie*.

Journal des Fabricants de Sucre.

SUGAR AS A RESPIRATORY FOOD.

The following extract from Dr. Smith's book on Foods is brought forward as one of the most interesting points in the animal economy —points over which sugar reigns almost as an absolute lord :—

"It is needless to show how universally this substance enters into the dietaries of every class in every place. There are, of course, immense tracts of country where sugar in a separated form is not obtained, but even then it is eaten in milk, fruits, and other animal and vegetable productions. Thus in the deserts of Arabia the tamarind and camel's milk are the chief sources of its production, whilst the fig, date, and innumerable luscious fruits yield it in tropical and other Asiatic countries.

"The following table shows the quantity of sugar which is contained in ordinary foods :—

Sugar in Various Products.

	Per Cent.		Per Cent.
Raw Sugar	95·0	Barley Meal	4·9
Treacle	77·0	Wheat Flour.....	4·2
Butter Milk	6·4	Rye Meal	3·7
Carrots	6·1	Wheaten Bread.....	3·6
Parsnips	5·8	Potatoes	3·2
Oatmeal	5·4	Turnips.....	3·1
Skim Milk.....	5·4	Peas	2·0
New Milk.....	5.2	Indian Meal Rice.....	0·4

"It is impossible to estimate the effect of the entire withdrawal of one important article from the food of mankind; but it may be doubted whether the loss of any one element would be so keenly felt as that of sugar. So necessary is it, in fact, that starch—the other universal vegetable food—is transformed into sugar in the course of chemical change within the body.

The ultimate chemical composition of dried sugar is as follows in 100 parts :—

	Milk Sugar.		Cane Sugar.
Carbon	12		12
Hydrogen	11		11
Oxygen	11 + water.		11

"There are 2·800 grains of carbon in 1 lb. of ordinary moist sugar, and there should not be any nitrogen.

"Ten grains of lump sugar, when burnt in the body, produce heat sufficient to raise 8·61 lbs. of water 1° Faht., which is equal to lifting 6,649 lbs. one foot high.

"It was indicated as the respiratory food *par excellence* in my *Mémoire* published in the *Annals de l'Académie des Sciences de Montpellier*, 1860; and is the most striking illustration of a respiratory food which we possess, for not only does it exert a great and rapid influence over the respiratory process, but it is itself entirely transformed into carbonic acid and water, both of which pass off from the body by the lungs.

"Its action is very rapid, commencing within five to ten minutes after it is eaten in solution, attaining its maximum in about thirty minutes and disappearing within two hours. My experiments on the different kinds of sugar have been very numerous, but it will suffice here to give a general indication of the results.

"One ounce and a half of white sugar dissolved in water gave a maximum increase in the carbonic acid evolved of 2·18 grains per minute, and of the air inspired of 111 cubic inches per minute. The rate of respiration and of pulsation was lessened.

"In an experiment when the whole of carbonic acid evolved was collected, it was proved that after taking 500 grains of white sugar in cold water, there was an increase of 1·57 grain per minute during the first half-hour, and of 0·58 grain per minute during the second half-hour; whilst after one hour and a half, the quantity was still increased by 0·12 grain per minute. The increase in the quantity of air inspired was 19·3 cubic inches per minute during the first half-hour, of 30·6 cubic inches per minute during the second half-hour, and of 8·3 cubic inches per minute during the third half-hour. When the sugar was eaten dry, the effect was less, but it was rapidly increased on drinking water.

"The addition of 6 drachms of good vinegar to 750 grains of sugar was to increase the effect of the sugar. The maximum increase of carbonic acid was 3·3 grains in 20 minutes; and the whole average increase throughout one hour and a half was no less than

1·24 grain per minute. The maximum increase in the air inspired was 79 cubic inches in 20 minutes.

"The addition of an alkali did not increase the effect of the sugar. Thus, 750 grains of white sugar with 50 minims of *Liquor Potassæ* and 12 ounces of water gave a maximum increase of 2·13 grains of carbonic acid per minute, but the increase in the quantity of air inspired was no less than 165 cubic inches per minute.

"The addition of 500 grains of butter lessened the effect of the sugar to a maximum increase of only 1·3 grain of carbonic acid and 48 cubic inches of air per minute.

"Milk-sugar has less influence than cane-sugar, and grape-sugar less than either; the maximum increase of carbonic acid from the former was 1·62 grain and with the latter 1.3 grain per minute, and of air 24 cubic inches per minute.

"There was always great ease and depth of respiration after taking sugar, so that it was so far an agreeable food, but in five minutes there was sometimes a sour taste in the mouth, and it differed from ordinary food in causing a craving for food in about an hour and a half."

We see here one of the many important uses sugar exercises upon the body. All nature's works seem "to second to some other use." Not only does sugar serve to build up the body—giving flesh; it also serves as an assistant in the great work of giving free life-breath.

Besides the above extract from Dr. Smith's book, the following table which we have compiled may be interesting to our readers, and will show to what an extent the substance, sugar, is an ingredient in our foods.

In the following table we have also the percentage amount of starch present in a few plants.

STARCH IN PLANTS.

	Per cent.		Per cent.
Arrowroot	82·0	Rice	79·1
Rye Meal	69·5	Barley Flour	69·4
Wheaten Flower	66·3	Indian Corn Meal	64·7
Oat Meal	58·4	Peas	55·4
Wheaten Bread	47·4	Potatoes	18·8
Parsnips	9·6	Carrots	8·4
Turnips	5·1		

Sugar in Plants.

		Per cent.	
Peas		2·0	
Maize		0·4	
Rice		0·4	
Oats		5·4	
Seconds Flour		7·01	
Hart's Meal		4·01	
Good Seconds Meal		4·2	
English Bread made from Seconds Flour		3·6	
Barley Meal		4·9	
Rye Meal		3·7	
Potato		3·2	
Apios	Starch, Sugar, &c.	33.55	Payen.
Potato	do.	21·20	
Turnips		2·1	
Carrots		6·1	
Parsnips		5·8	
Beetroot		8·0 to 10·0	
Common Cabbage, Woody Fibre, Gum and Sugar	Young plant 4·5		Anderson.
	Ripe only leaves 5·0		
	Ripe heart leaves 4·1		
Ripe Grape		13·8	
Kleinberger		10·59	
White Austrian		13·78	
Red Asmaunshäuser (ripe)		17·28	
Oppenheim, ripe		13·52	
,,	over ripe	15·14	
Johannisberg		19·24	
Mulberries		9·192	
Bilberries		5·780	
Blackberries		4·444	

	Per cent.	
Cherries, sour	8·772	Fresenius.
,, rather sour	8·568	
,, sweet black	10·700	
,, ,, light red	13·110	
Apples.		
English Rennets	6·830	Fresenius.
White Dessert	7·580	
English Golden Pippin	10·360	
Pears.		
Sweet Red	7·940	
Cane and Grape Sugar.		
Banana	19·66	Corenwinder.
Strawberries, wild	4·550	Fresenius.
,, cultivated, quite ripe	7·575	
Raspberries, wild, red	3·597	
,, cultivated, red	4·708	
Plums.		
Greengages, Yellow	2·960	
,, large and sweet	3·400	
Mirabelle, common yellow	3·580	
Apricots.		
Large Fine flavored	1·53	Fresenius.
Small	2·73	
Peaches.		
Large Dutch	1·58	
Gooseberries.		
Small, red	8·23	Fresenius.
Yellow	7·50	
Large, red	8·06	
Currants.		
White	7·12	Fresenius.
Red	6·44	
Very Large Red	5·647	

We have also given a table of starch present in a few plants used as food, because, as has been said elsewhere, the starch in plants used as food becomes converted into sugar in the body, and thus helps to build up the frame.

This conversion is one of the most wonderful chemical science takes cognizance of, and we may say, that it is also one of the most beautiful.

ON THE ANALYSIS OF THE URBAN CANE MANURE.

To the Editor of "The Sugar Cane."

Sir,

It often happens that commercial analysis of manures are not so satisfactory as they might be, and it is only superphosphate, or similar *artificial* manures, of which the value can be at all judged by being submitted to the tests ordinarily used in the laboratory of the commercial analyst and agricultural chemist. In the case of farm-yard manure and the Urban Cane Manure, which are to a great extent *natural* products, nothing but the most complete and careful analysis can possibly give the least idea of their composition and account for their wonderful effects on the soil. A sample of superphosphate is valued chiefly by the amount of acid phosphate of lime which can be washed out of it by pure water. This test does not apply to the Urban Cane Manures; though it yields some of its bulk to water, just as concentrated farmyard manure does, this soluble matter does not consist in acid phosphate of lime, but in a variety of organic and mineral substances.

In the pure unadulterated Urban Cane Manure there is usually 12 to 14 per cent. of moisture only, 26 to 30 per cent. of organic matters of various descriptions, yielding about 2½ per cent. of ammonia when the entire manure is distilled with soda lime; the phosphates of soda, magnesia, lime, ammonia, &c., amount to 19 or 20 per cent., and the remainder consists of salts of potash, soluble silica, sulphate of lime, and small quantities of other saline matters, the usual amount of sand or inert residue not amounting to more than 7 or 8 per cent.

The foregoing may be some guide to those agricultural chemists who have endeavoured to discover the composition of the Urban Cane Manure, but hitherto without success. If they would consult the pages of your valuable periodical for some years past, they would see that there is no secret whatever connected with this composition, and that full analysis of the manure in question have been published by myself.—I am, &c.,

T. L. Phipson, Ph.D., F.C.S.,
Member of the Chemical Society of Paris, &c.,
Professor of Analytical Chemistry.

London, 21st May, 1874.

To the Editor of "The Sugar Cane."

Sir,

In the summing up of the article entitled "Perfect gas heating by complete combustion," etc., the author invites direct communication with regard to the adoption of his system. I should be happy to receive from Mr. Charpentier further particulars with a view to the introduction of his apparatus in the manufacture of sugar where megass is the only fuel used. The publication of this will much oblige,—Yours truly,

Robert Graham,
Engineer, Ponce, Porto Rico.

April 20th, 1874.

Stocks of Sugar in the Chief Markets of the World on the 1st April, 1874, for Three Years, in thousands of tons, to the nearest thousand.

	1874.	1873.	1872.
Great Britain	209	120	93
France	188	138	73
Holland	48	57	44
Germany (Zollverein)	45	30	21
Six other *entrepôts*	9	7	5
Total in Europe	500	352	236

Consumption of Sugar in Europe and the United States for Three Years, ending 1st April, 1874, in thousands of tons.

	1874.	1873.	1872.
Great Britain	779	742	680
France	260	236	303
Germany (Zollverein)	284	257	216
Holland	28	24	13
Six other *entrepôts*	104	106	107
Total in Europe	1,455	1,365	1,319
United States	602	574	541
Total	2,057	1,939	1,860

Estimated Crop of Beet Root Sugar on the Continent of Europe, for the ensuing Season, compared with that of the three previous Seasons.

(From Licht's Monthly Circular.)

	1873-74.	1872-73.	1871-72.	1870-71.
	Tons.	Tons.	Tons.	Tons.
France	395,000	409,000	335,000	289,000
Germany (Zollverein)	285,000	259,000	189,000	263,000
Austro-Hungary	170,000	214,000	162,000	182,000
Russia and Poland	150,000	150,000	90,000	135,000
Belgium	72,000	76,000	72,000	56,000
Holland and other Countries	37,000	35,000	25,000	17,000
Total	1,110,000	1,143,000	873,000	943,000

SUGAR STATISTICS—GREAT BRITAIN.

To MAY 16TH, 1874 AND 1873. IN THOUSANDS OF TONS, TO THE NEAREST THOUSAND.

	STOCKS.						IMPORTS.						DELIVERIES.					
	London.	Liverpool	Bristol.	Clyde.	Total, 1874.	Total, 1873.	London.	Liverpool	Bristol.	Clyde.	Total, 1874.	Total, 1873.	London.	Liverpool	Bristol.	Clyde.	Total, 1874.	Total, 1873.
British West India	18	*	2	12	*	29	29	4	3	9	45	40	30	*	2	14	*	48
Cuba	4	..	3	15	..	11	4	4	8	13	29	9	2	..	7	17	..	16
Porto Rico, &c. ..	..	..	..	2	..	7	1	13	1	..	15	10	1	..	..	..	..	8
Brazil	6	..	..	4	..	27	7	29	3	5	44	42	4	..	3	6	..	35
Mauritius	6	..	1	3	..	10	8	1	5	6	20	29	5	..	5	4	..	25
British East India	12	..	..	..	..	16	5	1	..	..	6	17	6	..	..	..	..	13
Manilla & Java ..	34	..	2	8	..	37	11	12	9	14	46	29	9	..	8	8	..	23
Beetroot, &c.	8	..	..	6	..	9	26	6	3	13	48	43	23	..	4	13	..	55
Total, 1874 ..	90	69	9	51	219	147	91	71	32	60	254	219	80	54	29	62	226	223
Total, 1873 ..	67	45	6	30	72 increase		72	63	28	55	35 increase		72	48	28	75	3 increase	

* Returns of the stocks and deliveries of the different kinds of Sugar cannot now be obtained from Liverpool.

STATE AND PROSPECTS OF THE SUGAR MARKET.

This, the first month of free sugar, has witnessed an active trade in that article. The refiners lost no time in settling down again into regular work after the temporary stoppage caused by the welcome announcement of abolition of the duty.

The sales, both of raw and refined, were at first somewhat limited, owing generally to the indisposition on the part of sellers to accept prices lessened by the removal of the duty. Buyers were however firm, having regard to the large stock in the country, and by the middle of the month, it was evident that the market price was to be established at a considerable reduction; since then, a very large business has been transacted, and prices have again tended upwards.

There has, this month, been a considerable speculative demand for the lower classes of raw, doubtless engendered by the full price paid for lower refined. This however seems now to be satisfied, and low descriptions are again easier.

The latest quotations report: No. 12 Havana afloat, 25s. to to 25s. 6d. per cwt., or 1s. dearer than last month; fair to good refining, Cuba Muscovadoes, 21s. to 22s., or 6d. advance; midling to good brown Bahia, 18s. 6d. to 19s. 6d., against 17s. 6d. to 18s. 6d. last month. The price of common refined lump is 31s. to 31s. 6d., having thus lost rather more than half the duty.

The deliveries have, during the latter part of the month, been greatly stimulated; in other respects, the statistical position is little changed; stocks 219,000 tons against 147,000 tons this time last year. The intervention of the customs being now dispensed with, it will be for the trade to consider some method whereby the statistics may be accurately and reliably obtained.

THE

SUGAR CANE.

No. 60. JULY 1, 1874. Vol. VI.

☞ The writers alone are responsible for their statements.

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THE INTERNATIONAL SUGAR QUESTION.

From the "*Journal des Fabricants de Sucre*," of June 11th, 1874.

Twelve months more will bring us to the time, fixed by the National Assembly, for the establishment of the duties on consumption in France; and if we consider the influence which this new system must exercise on the sugar traffic, we shall agree that we cannot too soon enter upon the subject, and endeavour, from this moment, to form an opinion as to all the consequences. Unhappily, this important change coincides with other events, economical and political, which are happening or have happened, among interested nations, so that the attention of the sugar diplomacy is diverted from this subject, and the question is suffering a regrettable delay. In England, although we do not see any appreciable modification in the economical policy of the Government, a liberal has been replaced by a conservative ministry, and the important measure of the abolition of the duties has been effected. In France, political preoccupations and questions of impost, the latter having for their object, the difficult attainment of the equilibrium of the budget, reduce, to a second rank, problems of the first importance, such as that of which we speak. Scarcely has any ministry been allowed to acquaint itself with the first elements of the question, before it has been replaced by another, to recommence this Sisyphian labour. Thus

M. Teissereinc de Bort has succeeded M. Deseilligny, replaced by M. Grivart, who himself At last, Belgium having to renew a moiety of her Senate and Chamber of Representatives, refuses, till the end of the year, to act in concert with the sugar interest, when invited to do so; and declares to our Central Committee, as we shall afterwards see, that the time for the meeting of an International Congress of Sugar Makers, at Brussels, is inopportune.

This proceeding of the Central Committee, which the answer of the Society of Belgium Sugar Makers has made known to us, shows, at least, that the delegates of our sugar interest are of opinion that, if the National Assembly has managed to vote the principle of the duty on consumption, without troubling itself with the ways and means of establishing it, it cannot proceed further without a common agreement with the three other countries who are subscribers to the Convention of 1864. The refusal—somewhat disdainful—of the Society of Belgian Sugar Makers, which we do not wish to incriminate, nor misinterpret—considering their reasons for abstention—will it now enlighten us, and enable us to comprehend, that in engaging us, beforehand, on the principle of the duty on consumption, how it was we presumed too much on the good wishes of our co-contractors of 1864? This is what, on our part, we have not ceased to reiterate, and this proof, which keeps alive the fears we expressed, will, doubtless, not be the last we shall have to furnish. Many of our readers, however, think, as well as our English correspondent, that our fears are chimerical; and they cannot bring themselves to admit, as we do, that England can become disinterested on the sugar question. Without doubt she will "not disinterest" herself, in the literal sense of the word, and if she cannot make a special Convention with us, she will seek, in another way, to satisfy her general commerce *or* her refiners. But how will she do it, and are we not strengthened in our arguments when we hear: "For our part there is no doubt that the application "of the impost on consumption in France only tends to place the "national refinery at a disadvantage before foreign competition. We

"must endeavour to induce all Europe to adopt this basis of "impost. You believe the thing difficult—impossible. The "importance of the result is worth the effort to bring it about. "If we fail, we must throw ourselves back on raw sugar, and "propose to apply one of the three systems—French, Belgian, or "German—it matters not which, provided it be the same every-"where. In a word, the only way of solving the sugar question, in "my opinion, is to adopt the same legislation, the same basis of "impost, whether it be on raw or refined, in all sugar producing "countries."

Whilst calling attention to the perfect conformity of these ideas with those we uphold, we may still be permitted to add a few observations. Yes! the same legislation, the same basis of impost, must be adopted in all the sugar growing countries of Europe. But this principle can no longer be applied to England, which is freed from duties, and legislation in connection therewith; and as the English market is the principal object of all sugar producing countries, we can understand how important this objection is. As long as England had a duty on sugar, however small it was, we could justly admit, that the declarations of her refiners, that they were ready to submit themselves to work under bond, were made in good faith, and much to their credit. The abolition of the duty has neutralised the value of their good wishes, and it becomes necessary, henceforth, to seek another bond for the purpose of connecting them with us. "Establish the system of working in bond," they said, "and, on the strength of that measure, we will be certain that the "produce of the French refiners will not enter into unfair competi-"tion. That done, we shall be prepared to buy your raw sugars." That is good, and well spoken; but still it will be necessary, in order that these fine professions be realised, that the Dutch and Belgian refineries should be placed under the same laws. That is not all. At the time the Convention was established in 1864, the exportation of raw beetroot sugars had no existence, properly speaking, either in France or elsewhere. France, which produces to-day 400,000 tons, only then made 150,000. Germany, Austria,

Belgium, and Holland, produced on their part, one-half less than to-day. Europe in the aggregate had a production of 520,000 tons, whilst in 1873-74 this production has exceeded 1,100,000 tons.

We see, by these figures, what the course of raw sugars has been in the last ten years, and what an imperious necessity there is for seeking an outlet for this continually increasing flood. Exportation has consequently been made under all forms, especially into the greatest consuming country of Europe—into England. English refiners, divesting themselves of the prejudices they entertained against this product of continental blockade, have commenced using beetroot sugar on a large scale; and will do so more and more, to their advantage, by having recourse to all the producing countries of the continent. It has resulted from these new conditions of the sugar trade, scarcely foreseen by the legislature of 1864, that the Convention entered into, at that time, has become insufficient, and that, if we wish to renew it, it is indispensable to go more liberally to work and introduce new bases. This Convention had, indeed, no other object than that of putting an end to the abuses of the old drawback, viz., of suppressing the premiums accorded, respectively, to the refiners, in whom the sugar industry was personified and summed up. The new Convention, in proposing to reach the same end, ought, also, to have in view the abolition of the premiums realised on raw sugar. France, who receives the duty on the manufactured article, does not grant premiums to her manufacturers, and it is absolutely beyond doubt that not an atom of raw sugar proceeding from her factories escapes the impost. But we ask—is it so in Belgium, in Holland, in Austrian Hungary, in Germany, and we may add in Russia, supposing sugars to be, at some future time, exported from that country? Every one knows the contrary. In the two first countries, the imposts levied on the juice, on a principle of composition, evidently, leaves surpluses. In Austrian Hungary, the impost is levied discretionally, according to the capacity of each press or machine, used in the extraction of the juice. The Austrian sugar manufacturer is interested in making his presses turn out as much as possible; and he realises, in consequence, considerable

surpluses. There is the same system in Russia, where the surpluses, from the sugar manufacture, are a mystery to nobody. Finally, Germany levies the impost on the root, and everybody knows that all the economy of culture and sugar production of that country is based on this legislation, which compels the use of the very best roots, and admits of considerable surpluses.

The result is, that in all sugar growing Europe, one country only realises no premiums on raw sugars and that country is France. We have, it is true, indirect premiums on refined sugars; but these premiums, obtained for us by we know not how many diplomatic notes, and International Conferences, all so empty and barren, are to cease with the law on refineries on the 1st of July, 1875. From that day the French sugar interest will enjoy no premiums; the impost will be rigorously exacted, and to borrow a famous expression we shall be able to admire our sugar system "in all its beauty." But we ask—can we content ourselves with this esthetic satisfaction, and whilst we shall have consented to the application of a system which only leaves us the legitimate profits of a production more or less economic, that is to say, those of labour,—shall we, good Don Quixote, benevolently leave other nations to push their sugars by the various artifices of their legislation. This is the true difficulty, and it increases when we come face to face with England, who has just established free trade in sugar. Let us give real satisfaction to England, and when the system is once exemplarily established, and she opens her ports to our raw as well as refined goods, will she close them to similar productions of other countries, if the latter, not having adopted the same system, continue to allow premiums on their productions? If we remain free with free England, we need not occupy ourselves with that question; but if she become a party, on any terms whatever, to a new Convention, it is clear she should engage to reject the raw and refined sugars of countries, which shall not have adopted, like us, the principle of the repression of premiums. Already Austrian Hungary, where this system of premiums is more largely practised than elsewhere, has supplanted us in the English market,

and the equivalent of the surplus of 30 millions of kilos., which we have lying in our factories and entrepôts have been exported to England, by this rival nation, which has very quietly taken our place in London, Greenock and Liverpool,—thanks to her composition premiums.

Let us then be, no longer, dupes to our ideas and our sentiments which lead us towards generalisation, and the absolute, and let us look alone, to the normal development of our commerce and industry. We have decided, as a principle, that traditional premiums allowed upon sugar, in consequence of the imperfection of our different systems, should be suppressed by means of a legislation of fiscal rigour, mathematically exact. Let us ascertain, before engaging ourselves further, and carrying our principle into action, if the competing nations are disposed to associate themselves with us, diplomatically, for the same laudable object. England, with the applause of all economists and statesmen, worthy of the name, has abolished the duty upon sugars, and established free trade in that commodity, which is only inferior in importance to that of free trade in corn. Let us ascertain if the principles of this trade will not prevent her from intervening in the legislation of countries, which, less happy than herself, are still under the necessity of maintaining, with the complications and abuses resulting therefrom, an impost, more or less on sugar ; and let us assure ourselves that her principles, as a free trader, will not be roused, when any interference is attempted with a product she has just set free. In other words, it concerns us to know if that great consuming country, which has just carried into effect so great an economical reform, will be disposed to enter into an international arrangement, the immediate effect of which will be—an infraction of the very principle of that reform, and detrimental to some of the advantages which British commerce expects to derive from it. Will Sir Stafford Northcote, whose declarations are so precise, thus stultify himself? We do not think so. We expect much care will be exercised by the French Government, in its study of these grave questions, which we submit without the pretension of solving. As to the authorised represen-

tatives of home grown sugar, who have commenced this campaign, it is their duty to look after it, and no longer to leave the sugar industry in the difficult and equivocal position—full of uncertainty and peril—in which it is placed. This duty, we have confidence they will know how to fulfil, in giving us, as soon as possible, the formula or basis, on which, after the 1st July, 1875, the international sugar trade should be established.

(*Signed*) B. Dureau.

THE MANUFACTURE AND REFINING OF SUGAR.

By M. Prosper Legrange.

Being a Report on the Action of Caustic Baryta and Basic Phosphate of Ammonia, on the Products of the Saccharifcrous Plants. Also, on the Industrial Manufacture of the Hydrate of Baryta and Basic Phosphate of Ammonia.

Translated and condensed for the *American Chemist*, by Waldron Shapleigh, F.C.S.

This memoir was presented to the "French Academie des Sciences," by M. Péligot, last November, and as this process is in successful operation, in several works and refineries, a description of the method, and its application, cannot fail to be of interest to persons engaged in the sugar industry.

Part I.

I. *Methods actually employed in the sugar industry; their imperfections.*—Since MM. Kuhlmann and Rousseau introduced the treatment of the sugar juices, by lime, and the extraction of this alkali, by carbonic acid, the methods of purification have made but little progress. The principles remain the same; the mode of application alone has changed.

The methods, called the double carbonatation, troubled carbonatation, &c., are but modifications of the primitive principle—that is, lime and carbonic acid form the base; the proportions and treatment vary. These different methods eliminate but a part of the molasses forming bodies, and leave in the products, treated, a

number of foreign substances, which resist their action. These are the substances the new method proposes to eliminate, for the purpose of augmenting the yield of sugar, at present so limited.

II. *Opinions of the savants, on the bodies causing the formation of molasses.*—The hurtful influence of salts, and organic matters, on the crystallization of sugar, is a fact well known to all chemists, especially occupied with the subject of sugar. They regard the organic matters fully as injurious as the mineral salts. Whatever be the difference of opinion, it is certain that, in the molasses, the sugar, that cannot be extracted, is nearly always accompanied by 10 per cent. of salts and a very large proportion of organic matters, and, that the hurtful action, of these bodies, on the separation of the sugar, is evident.

III. *The object of the employment of baryta, and basic phosphate of ammonia.*—This new method of purification is based upon the elimination, by the double action of baryta, and basic phosphate of ammonia, of those mineral and organic compounds, which impede the crystallization of the sugar, and which escape the calco-carbonic treatment, at present employed.

This calco-carbonic method is far from being perfect; not only does it leave, in the juices, and syrups, a large quantity of foreign matters, hurtful to the crystallization, but, it also gives, to the organic acids, a base, lime, to form salts which the carbonic acid cannot decompose.

IV. *Action of baryta, on certain organic salts of lime, on the alkaline sulphates, and on the organic salts of soda and potash; action of the basic phosphate of ammonia on the salts of lime.*—Independent of the organic salts of lime, not decomposable by carbonic acid, in the sugar juices, there also exist sulphates of soda and potash, and also, these alkalies combined with vegetable acids.

These bodies, which render difficult the manufacture, and increase the quantity of the molasses, are eliminated, to a great extent, by the use of the two reagents, used in this new process. The organic salts of lime, not decomposed by carbonic acid, cannot resist the action of basic phosphate of ammonia, which forms insoluble phosphate of lime, and salts of ammonia.

Among these organic salts of lime, there exists one of a peculiar nature, which is precipitated by baryta, without forming a direct combination with it; this organic lime salt, precipitated in part by the baryta, is found in the residue, in the form of insoluble carbonate of lime. Experience has shown, that the addition of baryta, always, precipitates a third part of the lime, contained in the syrup. The peculiar coagulating effect, of the reaction of baryta, on the organic salts of lime, and that of the phosphate of ammonia, also, plays an important part in this process; so also the action of baryta, in decomposing the sulphates of the alkalies and alkaline earths, forming sulphate of baryta, and setting the alkalies free. This action, of the baryta, equally applies to the decomposition of the vegetable acids, in combination with the potash and soda. The calco-carbonic treatment cannot eliminate them. This base, not only acts directly, and by coagulation, but it also acts indirectly, by forming organic salts of baryta, insoluble in an alkaline, and soluble in an acid medium, and sets free the alkalies, soda and potash. These alkalies decompose, completely, the salts of ammonia, the ammonia being volatilized.

V. *Action of the baryta, and phosphate of ammonia, on the products of the cane, working alkaline without lime.*—It is, above all, in the juice of the cane, that the baryta manifests the most energy. This juice contains but little mineral salts, and but a small proportion of sulphates, so small that it is not worth while to preoccupy one's self with their elimination. On the contrary, however, the quantity of organic acids is very considerable. These acids are at liberty, or combined with the soda, and potash. Baryta possesses a special and very remarkable affinity for vegetable acids, and forms, with them, insoluble salts, which precipitate, in the form of a lake, taking down, with it, a considerable quantity of the colouring matter.

These salts are insoluble, in an alkaline, and soluble, in an acid medium; thus the alkalies, set free, favour, admirably, this insolubility. The study, of this remarkable reaction, has permitted the solution of an industrial problem of the utmost importance, that of keeping the juices and syrups of the cane alkaline, without

the use of lime, or salts of lime, and through all the series of industrial operations, thus preventing the formation of glucose at the expense of the crystallizable sugar.

In the treatment of the cane juice, there are two obstacles equally disastrous—that of defecating, with too little or too much lime. In the first place, when the defecation has been deficient, so that but little lime is left in the syrups, it is not prevented from becoming acid, and then, the transformation of the crystallizable sugar, into glucose, makes rapid progress. This is the case with the work, as conducted in all the colonies, consequently, the sugar, when it arrives in Europe, is charged with glucose. In the second case, if one defecates, in such a fashion, as to render alkaline the juices, by an excess of lime, it is, then, that the vegetable acids, for which the capacity of saturation, by this alkali, is very great, form the organic salts of lime, which are so very objectionable in the evaporation, crystallization, and turbinage; but if, after having defecated slightly, with the lime, so as to obtain alkaline syrups, the baryta and phosphate of ammonia are added in succession, the base decomposes immediately the vegetable acids combined with soda and potash, to form, in part, an insoluble organic salt of baryta, and sets free the alkalies. The salts of lime are equally decomposed, by the phosphate of ammonia, and, as a result, we have insoluble phosphate of lime and a disengagement of ammonia.

VI. *Experiments on the employment of phosphate of ammonia.*—Several chemists, among others,—Kuhlmann, have proposed the phosphate of ammonia, in order to eliminate the organic salts of lime, not decomposed by carbonic acid. These chemists have employed phosphate of ammonia alone, and have never obtained good results. The lime was perfectly eliminated from the juices and syrups, but, after the boiling, these last were always acid, and, for this reason, all the attempts made, with this salt, have failed.

If I have thought of the basic phosphate of ammonia, it is because I have seen the stumbling-block of my predecessors, and have been enabled to avoid it by the use of baryta in this decomposition.

The alkalinity, which it is impossible to obtain, with the use of the phosphate alone, is not the only danger that presents itself in the employment of this salt, but it is, also, necessary that the phosphate of ammonia be completely exempt from sulphate of ammonia, or this will form, in the reaction, sulphate of lime; this salt, nearly always, exists in the raw sugars, and, consequently, in the syrups, and, in greater or less proportions, dependent upon the care taken by the manufacturer. It is decomposed, by the phosphate of ammonia forming insoluble phosphate of lime, and soluble sulphate of ammonia. The latter not only constitutes, in itself an impurity, and, not only, exerts, on the yield and the crystallization, the same action as the other objectionable salt, but it, also, possesses another property, more dangerous, namely, during the ebullition the sulphate of ammonia is changed into sulphuric acid, which transforms the crystallizable sugar into glucose, and starts fermentation in the syrups. The mere inversion of the sugar is not the only damage, caused by the sulphate of ammonia, but this salt renders the product gummy and viscid, so that, when it arrives from the vacuum pan, it cannot readily be worked in the turbine; the syrup will not separate from the grain. The same applies to the refining of sugars, in the difficulty in clearing the loaves; the green syrup remains in the crystalline mass. This grave difficulty disappears, in the employment of baryta; this base decomposes the sulphate of lime, forming insoluble sulphate of baryta, and the lime, being then free, is precipitated by the phosphate of ammonia.

VII. *Absolute purity of the phosphate of ammonia.*—This hurtful action of the sulphate of ammonia, on the sugar, demonstrates, sufficiently, the necessity of having the phosphate of ammonia absolutely pure, and free from all traces of sulphate of ammonia. To this end, the preparation of the phosphoric acid, destined to be employed in the production of the ammonia salt, is made, by the action of sulphuric acid, on the mineral phosphates. In spite of the best treatment, there, always, remains some sulphuric in the phosphoric acid, and, if precaution is not taken,

to separate the sulphuric acid, there will, always, be sulphate of ammonia with the phosphate.

If those who have attempted to work, with the phosphate of ammonia alone, have not observed, rigorously, this imperative necessity, it was impossible to prevent the syrups, on which they worked, from becoming acid, and, consequently, forming glucose. Phosphate of ammonia, even though chemically pure, and exempt from sulphate of ammonia, would not, as I have said before, without the use of baryta, maintain the syrup alkaline, without lime or the salts of lime. One obtains, by the double decomposition of the organic salts of lime, by the basic-phosphate of ammonia, only neutral syrups. In the different industrial operations, a neutral syrup is not prevented from becoming acid, under the influence of heat, and the ferments which develop themselves; here it is, that the potash and soda, separated, by the baryta, from sulphuric, and the vegetable acids, with which the alkalies are in combination, play an important rôle. These alkalies, as we have already said, far from being hurtful to the sugar products, are enabled, within certain limits, to assist the crystallization, and the turbinage, to render the grain dry and hard, and to protect it against all species of alteration. In this essentially alkaline medium, the ferments cannot develop, and the sugar finds itself free from their hurtful action.

This alkalinity, of the syrups, is maintained, with the greatest ease, in the evaporation and successive crystallization, as far as the molasses, which is not the case with the old method; for, unless great care has been taken, it is necessary to add, to each run, milk of lime. And, moreover, the potash and the soda, separated from their organic or mineral combinations, are very much easier absorbed by the boneblack. I have observed that, with these conditions, the elimination of these alkalies, by the black has been one-third greater than when they are in combination with mineral or vegetable acids.

VIII. *Origin of the sulphates of the alkalies and alkaline earths contained in the raw sugar.*—All the domestic raw sugar that the refineries receive, from the fabrics, with but few exceptions, have

the alkaline sulphates in proportions varying with the soil, the nature of the manure, and the more or less care that has been bestowed during the fabrication.

Very small traces are found in the sugar cane, and it is not necessary to occupy ourselves with their separation; the proportion of the sulphuric acid, in the beet sugar, varies from 0·10 to 0·50 per cent. This quantity of the sulphates, in the sugars, does not seem to correspond with the small quantity of these salts which is found in the ashes from the incineration of the beet. M. Péligot has stated that these ashes contain but 1 or 2 per cent. of sulphates. We then ask, under what circumstance the sulphuric acid is introduced; was it, during the growth under the influence of certain chemical manures, or, during the different phases of manufacture?

The researches we have undertaken, on this subject, show, that the normal quantity of sulphuric acid did not seem to change, even when chemical manures, containing soluble sulphates, were used.

The proportion of the salts remain the same, that is to say, does not increase in the juices of the sugar, as far as the carbonatation. After the carbonatation, if the juice be analyzed, we find the proportion of sulphuric acid is much greater than before. Having made analysis of the gas, used for the saturation, we have found, nearly always, a large quantity of sulphurous acid, which has led us to think it the source of the sulphuric acid. The carbonic acid is prepared industrially, and especially, in the fabrication of sugar, at a high temperature, in furnaces having successive layers of coke, and carbonate of lime. The coke, even when washed and prepared with care, always contains sulphides, which are decomposed, under the influence of heat; the sulphurous acid passes over with the carbonic acid, and gives birth to the sulphides, which, during the after operation, are transformed into sulphates; such, with but few exceptions, is the origin of sulphates, found in nearly all raw sugar.

IX. *The action of sulphate of ammonia in the culture of the beet; its decomposition by this plant.*—The beet has, during its

growth, such a slight affinity for sulphuric acid, that it has been, almost impossible, to prove a trace, even in beets manured with sulphate of ammonia; this is perhaps a peculiar fact.

In the Nord, there is a marked tendency to employ chemical manures, to hasten the culture, and, with the nitrate of soda, they do not hesitate to employ sulphate of ammonia. I have examined, with great, care, beets raised by this culture. The analyses have given me twice the amount of nitrogen, in such beets, that is found in those raised with ordinary manure. I have, however, seldom found sulphuric acid. This extraordinary, and interesting fact demonstrates, once more, that the sulphate of ammonia ought not to be rejected, and, above all, ought not to be considered a dangerous enemy to the culture of beets and their yield of sugar. The plant, manured with sulphate of ammonia, assimilates then the nitrate of ammonia, and the alkalies of the earth saturate, and neutralize the sulphuric acid, set free by the work of the nutrition of the plant, and act as a veritable and admirable reaction.

X. *Mode of the formation of the vegetable acid in the beet; organic salts of lime not decomposed by carbonic acid.*—If sulphuric acid appears, frequently, to augment, accidentally, the proportion of the salts in the sugars, it is not the same with the vegetable acids. These acids, all having different origins and natures, appear in the beet and undergo different modifications under the influence of the ferments, and sundry principles, enclosed in this plant. If these vegetable acids, united with potash and soda, are modified under diverse influences, the alkalies remain fixed, from the maturity of the beet, until its decomposition. The greater part of these acids are but modifications of the pectose, under the influence of the pectase. The baryta, as we have said, acts on these salts, decomposing them. After the râpage, when the juices, of the beet are separated from the pulp, and are treated by lime, a part of the vegetable acids are united with this base, one part being eliminated, under the form of insoluble organic compounds, the other, after the treatment, remains, in the juice, under the form of soluble organic compounds of lime; and these combina-

tions are much the more stable, as these vegetable acids have an astonishing capacity for saturation. Carbonic acid is without action, on these soluble organic lime salts.

Basic phosphate of ammonia, associated with baryta, is the only rational and efficacious remedy that can be employed to combat all the troubles these compounds give, to the equilibrium of a good fabrication.

XI. *The recovery of phosphoric acid and condensation of ammonia.*—When the phosphate of ammonia is made to act, on the salts of lime, we have two distinct phenomena: 1st. The lime is precipitated, as insoluble phosphate of lime; this, separated by filtration, from the juice and syrups, is, after washing, sent to the filter press, from which it comes in the form of a cake, containing all the phosphoric acid employed. This phosphate of lime can then be treated, anew, for the extraction of the phosphoric acid, or employed, in agriculture, in the form of super-phosphates; it is for this purpose it is employed, at present. 2nd. The ammonia, separated from the phosphoric acid, by the double decomposition of the salt of lime, passes off, during the ebullition, under the influence of the alkalies set at liberty. If this ebullition is conducted, in a closed tank, the ammonical vapours, may be condensed in a solution of phosphoric acid, thus economizing a large part of the ammonia employed. Thus, these two agents, after having marvellously served in the purification of the sugar products, the one to eliminate the base, the other to separate the acid, may be reobtained, in order to effect anew the purification of sugar juices, or give their fertilizing properties to these plants. This is the order of the action, and theoretic development which occur from the simultaneous application of the hydrate of baryta, and basic phosphate of ammonia, to the products of the cane and beet.

Part II.

I. *Industrial application of the baryta and basic phosphate of ammonia to the products of the factory and refinery; the method of the operation in the works; treatment with the baryta and basic phosphate of ammonia.*—After having demonstrated, from a

theoretic point of view, the reactions, to which the application of the baryta and phosphate of ammonia gave birth, in the treatment of the products of saccharifcrous plants, it cannot be without interest to trace, in a rapid manner, the practical working of this new method, in the fabric and refinery, the industrial and economic advantages which it procures, and to give an exact idea of the industrial fabrication of baryta, and basic phosphate of ammonia. Several important establishments are already operating this process with success; they ordinarily apply the baryta, and phosphate of ammonia, to the syrups of the beet, and in the fabric of cane sugar; these reactions are employed on the juices. After the first operations of the râpe, and the press, the defecation, and the saturation, the juice is decanted and filtered, through the black; it is then sent to the triple effet, in order to be concentrated to 20° B. It is, at this phase of the work, that the purification is made. The syrups at 20° B., being led into boilers furnished with a serpentine, or a double bottom of copper or of sheet iron, are heated to 80° or 90° C., at which temperature, a solution of baryta, or a milk of sucrate of baryta, is added in proportions varied with the quantities of precipitable matter which is found. The mean dose is from two to three kilos. per ten hectolitres of syrup, at 20° B. In order to determine the maximum quantity of baryta, necessary in this reaction, it is important to find, in what proportion, sulphuric and organic acids exist.

The following are the analytical methods we make use of:—

In order to determine the sulphuric acid, and the sulphates, we employ the volumetric method of MM. Boutron and Boudet, which is more rapid, in execution, than those made by weights, and is based on the following principles: If, to a pure calcareous solution, a given quantity of baryta is added, it augments, to a definite degree, the hydrotimetric strength of the solution (the soap base of the baryta being equally insoluble).

But if the solution contains sulphates, a certain quantity of the baryta will be precipitated, and the apparent strength consequently diminished; the difference, between what the total would have been, had the solution been free from sulphates, and the strength

thus found, indicates the baryta precipitated; therefore the quantity of sulphuric acid, contained in the liquors analyzed. To analyze the organic acids precipitated by baryta, we have recourse to two methods, which give very exact results: the first consists in treating the syrup by a standard solution of nitrate of baryta, added, in excess, and after neutralization, determining the diminution of the strength of the liquor; knowing the quantity of the existing sulphuric acid, it will be easy to determine the weight of the vegetable acids that the baryta has saturated. The second method is longer, the analysis is by weight, but the results are not less exact; it consists in precipitating, by an excess of very pure baryta, the sulphuric and vegetable acids in the syrups under analysis. The precipitate, formed of sulphate of baryta, and organic salts of baryta, is collected, on a tared filter, washed until the wash water contains neither sugar nor baryta, dried at 100°, and weighed, then incinerated, and the product treated by hydrochloric acid; the carbonate of baryta, formed during the incineration, alone is dissolved by the acid, and the sulphate of baryta is then collected on the filter, washed, calcined, and weighed. The acidulated wash waters are collected, the baryta, which is dissolved in them, is that which was combined with the vegetable acids; it is precipitated anew, by sulphuric acid, and determined by weight. One has thus the quantity of sulphuric, and, also, the vegetable acids, contained in the liquor; consequently, the equivalent proportion of the baryta saturated by these acids. However, in practice, to avoid the addition of an excess of baryta, it is necessary to keep, in the syrups, about one per cent. of the matters precipitable by this base; this amount the black can absorb easily, but, beyond this quantity, there will be but little chance that these impurities will be totally eliminated, especially with the small proportion of black usually employed, in these fabrics.

The baryta being added to the syrups, and the liquid agitated strongly, as soon as the sulphuric and vegetable acids, combined with the alkalies, are precipitated, in the form of insoluble salts of baryta, in the alkaline syrup, the phosphate of ammonia may

be added, in order to decompose, and form insoluble phosphate of lime, from all the salts of lime that escape the action of carbonic acid.

The quantity of basic phosphate of ammonia, employed in this reaction, is proportional to the salts of lime which exist in the syrup to be purified. An hydrotimetric analysis determines, rapidly, the weight. As a mean, one kilo. of crystallized phosphate, per 10 hectolitres of syrup, at 20° B. In order not to add an excess, and to use the absorbing properties of the black, 5 to 10 per cent. of lime are ordinarily allowed to remain; this quantity is regulated, by the more or less absorbent action, and the quality of the black. Nothing precise can be given, but only to indicate the method of the work, to be followed, in order to apply the process with success. The precipitate resulting, from the reaction, is a mixture of sulphate and carbonate of baryta, carbonate and phosphate of lime, with a large proportion of organic matter, thus constituting a fertilizer easily assimilated. The precipitate is retained, in the bags, of the Taylor filter, the syrups, limpid and purified, pass into the ordinary method of work, and are submitted to evaporation, in the vacuum, or in air as the case may be. After the filtrations, the bags of the Taylor filters are withdrawn, washed, and, with the scums of the defecation, pass into filter-press. In the colonies, with the product of the cane, the work is as follows: The cane juice, after leaving the crushing mills, is immediately treated with the ammonia or baryta, or by the milk of lime, in order to saturate the principal acids which are contained in it, and an alkaline reaction (to turmeric paper) obtained.

If the process of defecation be followed, a sufficient quantity of lime is added to give, after the decantation, a slightly alkaline juice. One need not then fear the grave consequences of having an excess of lime, which forms in the juice of the cane, the calcareous combinations so stable and hurtful, which we have studied, and of which we have previously spoken, when we have in hand, as a remedy, the phosphate of ammonia used in connection with baryta.

In the works, where the process of carbonatation is used, the lime is extracted with carbonic acid, and then, the phosphate of ammonia added, in order to take out the lime still remaining in solution, in combination with the vegetable acids; then, in order to maintain the alkalinity, so indispensable, and which disappears, so promptly, with the separation of lime, and the evaporation of the ammonia salts, a solution of baryta, or milk of the sucrate of baryta, is added, in quantities agreeing with the analysis, then it is brought to ebullition; as, in the juice of the cane, there is but little sulphuric acid, the vegetable acids, combined with the soda and potash, are precipitated in the form of a lake, carrying down, mechanically, a large part of the colouring matter, and remaining insoluble in the alkaline medium, thus formed, and which is maintained, very readily, throughout all the phases of the work. These precipitates are separated and collected, in Taylor filters, which appear to be best adapted to this process.

With this method, one obtains sugars of great whiteness, containing but a trace of glucose, which appears to be that which pre-existed in the cane, and, above all, sugars that will bear transporting to European markets without being liable to alteration.

II. *Economic advantages resulting from the employment of this process in the sugar manufactories; evaluation of the returns.*—The advantages resulting from this mode of treatment in the factory are—

1st. The regularity, and uniformity, to the close of the fabrication, the same remark applying even to the changed, or altered beet; of the yield of the "cuite" in grain, or in free air.

2nd. The augumentation of the value of the second and third products; for instance, in a fabric, which, at the commencement of the season, working with fresh beets and the ordinary process, has a yield of 75 kilos. in grain per hectolitre of the "mass cuite;" later, as the season advances, this yield will be reduced to 65 kilos. under the influence of foreign matters, which are formed during the alteration of the beet in the "silos," and which oppose, to a certain degree, the extraction of the sugar.

The treatment, with baryta and phosphate of ammonia, by eliminating these, gives syrups of sufficient purity, and a regular yield, from the commencement to the close of the fabrication, with great facility.

The second and third sugars, being separated from a large part of the mineral salts, the whole of the lime salts, and a number of the organic matters, crystallize, with great ease, and give a product of 4 to 5 per cent. better than the old method.

In commercial transactions in France, sugar is valued at the rate of 1 fr. 50 per degree, consequently, a sugar, having 5 degrees more, has an increase in value of $5 \times 1{\cdot}50$ or 7 frs. 50 per 100 kilos. Independently of the advantages it exerts on the yield of the first product, and improvement of the second, and third products, by the separation of the salts of lime, there is another; though it does not suppress the use of bone-black, it diminishes, to a notable degree, the consumption of this valuable article.

From a number of experiments, made on the industrial products, we have shown that the bone-black, is, to the phosphate of ammonia, with regard to the absorption of lime-salts, as 1 is to 7. Another advantage, in the employment of this process of purification, is the solution of the problem of an alkaline "cuite" without lime, or salts of lime, the potash and soda, set at liberty by the precipitation of the mineral and vegetable acids, with which they were in combination, under the influence of baryta, maintain the alkalinity, even to the molasses. One need not fear heavy or immovable "cuites," grain badly formed in the vacuum pan, nor difficulty in the separation of the syrups, from the grain in the turbine, difficulties occasioned by the presence of lime and its salts, which are, in the present mode of working, indispensable to maintain the alkalinity of the products, and which cause heavy losses to the manufacturer.

The elimination of lime, and its salt, facilitates, to a great degree, the application of a process, of which every one knows the value and principle,—the process of osmose of M. Dubrunfaut. No one is ignorant of the fact, that this illustrious and indefatigable champion of science applied, to the grand industry of sugar, the

dialytic membrane of Dutrochet, in an ingenious apparatus for continued osmose. Whoever has studied, and practised osmose, ought to know that, with the purification of molasses, by this process, lime and its salts are but little diffusible, and thus incrustations are formed on the parchment paper. This deposit impedes, and arrests the good effect of osmose, and necessitates frequent change of paper. I have had an opportunity of seeing the working of molasses, from the baryta process, which, being free from lime salts, I found to work with much better results, and the alkalinity, so essential to this kind of work, resulting from soda and potash, give new intensity to the forces of osmose.

III. *Application of this method to the products of the refinery; advantages, industrial and economical; suppression of blood; "cuites" alkaline without lime; wash waters alkaline; working of the scums simplified; filter-press; increase in the weight of the loaves.*—In the refinery, this new process works with the greatest regularity; several establishments, in France and abroad, have been installed, and the advantages which have resulted are not less than in the factory. The chemical precipitation, by the baryta and phosphate of ammonia, clarified, admirably, the syrups from all impurities. This property has enabled us to suppress, from the clarification, the use of blood and fine bone-black. The employment of blood, in the syrups, causes the products to be extremely sensible to alteration, and has always been regarded as a disastrous operation, on account of the fermentable principles which are inclosed in it, and which have a very energetic action on the sugar. This subject has attracted much attention from chemists, and these principles are sufficiently well known to render further words unnecessary. Therefore, among the advantages of this process, in the refinery, prominently stands the suppression of the use of blood. The germs of fermentation, which exist in raw sugars, and which find a natural development with the employment of blood, are energetically combated and destroyed by the alkali set free, and the elimination of the organic matters, by the baryta.

With the clarification by blood, one does not always obtain

alkaline liquids. After the filtration on the bone-black, they are generally neutral or acid. The syrups are, in this condition, sent to the vacuum pan to be boiled to grain; the glucose, developed, not only colours the product, but gives, to the mass, such viscosity, that the grain forms but imperfectly, and the green syrup separates with difficulty; this is often the cause of yellow and moist loaves.

With the new method, we have demonstrated that the syrups maintain a perfectly alkaline reaction, and lessen the difficulties of work.

Another grave inconvenience of the clarification by blood, is to have the wash waters, from the large filters, very acid, as this always develops a true lactic acid fermentation. The waters become milky in proportion to the lowering of their density, and their taste, beginning at 5° B., is insupportable. As these waters, charged with glucose, serve again, at the melting, they carry, to the charge, all the bad principles they contain. The alkalinity, developed in the bone-black filters, by the employment of this process, is such, that the waters even at 0° B. preserve their limpidity, and are exempt from all alteration, their taste resembling water slightly sweetened. Another benefit is the simplification of the working of the scums. As the precipitate is less bulky than that formed by the use of blood and fine black, there is less loss of sugar in the residues, and they may be washed with much less water; consequently, there is less to be evaporated, and these waters are always alkaline. The precipitate, by its nature, being less viscid, the screw, or hydraulic press may be replaced by the filter press, an apparatus of much greater simplicity. We have noticed, as an advantage in the works, the absolute elimination of calcareous compounds; in the refinery the same holds good; in it the marked benefits are this elimination, the sustained alkalinity, and the absence of glucose, in the syrups, destined to make the loaves; their being free from viscosity permits the "cuites" to be drier and to give larger yield in the loaves; for instance, in the old method the loaves weigh 10 kilos. 50, while, with the new process, using the same forms, the loaves weigh, as a mean,

11 kilos. 30. The difference then is 800 grammes and more per loaf, or, in a fabrication of 100,000 kilos. per day, it equals 8000 kilos., which cost, neither more time, labour, nor fuel.

IV. *Treatment of the lower products; sugar of the bastards and of the tanks going direct to the charge.*—In the treatment of the residues, which form, in the four products of the refineries, one can boil and put to crystallize, without the addition of lime to prevent fermentation, as the alkalinity preserves these products, even to the molasses, and gives the conditions for good crystallisation and turbinage.

The sugars of the bastards and the tanks, which have previously come from the turbines, can be sent directly to the charge; these, in former times, it was necessary to remelt and recrystallize in order to purify.

The very sensible increase of the ordinary yield, and the other advantages mentioned, are not hypothetical, but true, and which we can vouch for, having them continually under our eyes.

From the *American Chemist.*

(*To be continued.*)

PHOSPHORIC ACID IN SUGAR REFINING.

By Dr. C. Scheibler.

Translated for the American Chemist by J. M. Merrick, B. Sc.

[A paper entitled The Preparation and Employment of Phosphoric Acid for Removing Lime from Saccharine Juices, and upon the Rational Application of Superphosphate in Sugar Refining, by Dr. C. Scheibler.]

The author, who, several years ago, recommended the use of phosphoric acid for removing lime from, and for neutralizing beet juice, and later, as an addition to the water used in expressing the juice, has recently given, under the above title,* an important contribution to a more effectual purification of saccharine juices,

* Zollverein Zeitschrift, xxiii. 973.

and to obtaining a greater product of crystalline sugar from the crude materials.

After the author has referred, in the first part of his treatise, to the efforts of Brondc, Kohlmann, and E. Pfeifer, which have not yet been crowned with success, he remarks that, on one side, the difficulty, in a large way, of freeing the precipitate of tribasic phosphate of lime, produced in sugar juices by phosphoric acid, without causing a loss of sugar, stands in the way of favourable results, and that, on the other side, is the high price of the acid, and the fear of introducing a considerable amount of gypsum into the juice, since it is difficult to prepare the acid free from sulphuric acid, and free from sulphate of lime.

The caustic lime remaining in the liquors, after the ordinary separation, and the organic salts of lime, are, to be sure, removed in great part, by the subsequent saturation and filtration, but the latter never so perfectly as not to favour in a high degree the formation of molasses; and with the most complete possible removal of these lime salts, the practical refiner, whose effort is to get out of his solutions all substances not sugar, draws nearer his goal.

To support this, the author brings forward a research which we repeat here literally, since it is peculiarly adapted to give a clear notion of the essential principles of this method of purification.

When the author treated old, normally thickened molasses, from which sugar no longer crystallized, with so much phosphoric acid as was necessary to precipitate, very nearly, all the lime, then filtered off the precipitate, and evaporated the filtrate again to exactly the original density—*i.e.*, to the weight of the molasses employed, minus the previously determined bulk of the caustic lime—a considerable amount of sugar crystallized, but after long standing—generally after some months.

One of these experiments was made in 1868 with a molasses that had stood among the samples ten years without depositing sugar. The union of two determinations, with oxalate of ammonia, showed this molasses—with a sugar per cent. of 53·7—to contain ·11 per cent. ($\frac{11}{100}$ per cent.) of lime, as caustic lime. Four hundred

grammes (400 grammes) of this, corresponding to ·44 grammes lime, were then mixed with so much phosphoric acid, of known strength, as was necessary to precipitate about ·40 grammes of lime, in the form of tribasic phosphate. The filtrate and the wash-water from the precipitate were evaporated upon an oil-bath, without loss to the original density, 399·6 grammes and 393·8 grammes of this molasses, after cooling, poured into a glass vessel closed with a glass stopper. After some time, crystallization began, and after a lapse of about a year, in this purified and nearly lime-free molasses, large and beautifully-formed candy crystals had formed upon the walls, and especially upon the bottom of the vessel, and from these, the syrup was poured off, as completely as possible.

The crystals, which clung very firmly to the glass, could not be separated without loss. They were dried with blotting-paper, separated, so far as possible, from the adherent molasses, dried, and weighed. They amounted to 14·1 grammes, and an analysis of the crystals gave—

Sugar	98·20	per cent.
Ash	·74	,,
Organic matter not sugar	1·06	,,
	100	per cent.

Thus from the 400 grammes of molasses, were obtained 14·1 or 3·53 per cent. crude sugar, or 3·47 per cent. chemically pure sugar.

From this experiment, the author concludes that the presence of ·4 grammes of lime, in the molasses, prevents the crystallization of 13·85 grammes of chemically pure sugar, or 34·6 times its weight; but the remark must here be made that we are by no means justified in attributing to the lime alone this melassimetric coefficient 34·6, since, not the lime alone, but the organic salts of lime, are molasses-formers. These acids, when set free, by the phosphoric acid added, neutralize the free and carbonated alkalies, and diminish thus their [the acids] molasses-forming power.

According to the author's observations, the action of the phosphoric acid is not so simple as at first appears, for the phosphoric acid, in the precipitate, formed, is never combined with three equivalents of lime, but appears to be saturated, in part, by an

organic nitrogenous basic combination, whose further study the author proposes to undertake. Practice must decide the most favourable moment for adding the phosphoric acid to the juice, but in reality only four periods are possible, viz.—1st. After the separation and saturation of the juice; 2nd. After the filtration of the thin liquor, or before its evaporation in Robertson's apparatus; 3rd. After the filtration of the thin liquor, after its evaporation in Robertson's apparatus; 4th. After the filtration of the thick liquor, before its boiling down in vacuo. If it be desirable to let the lime act for a longer time upon the sugar-juice, the de-liming will not be brought about at period 1, but must be introduced later. Further, in those syrups which show little alkalinity, or an inclination to turn sour, the removal of the lime will not be effected at points 1 and 2, when the syrup possesses only slight alkalinity, but the refiner will wait until periods 3 or 4. When the alkalinity has increased with the concentration, de-liming, at the 1st period, has the advantage that the task of removing the lime does not devolve upon the bone-char in the following filtration, and that the coal can remain effective longer, since it can exercise its full absorbent power, upon the other matters not sugar.

In all cases, the application of phosphoric acid must be made only upon the basis of an analytical determination of the lime contained in the juice, and the quantity of acid, employed, must be such as to leave in the solution a slight amount of lime, *unprecipitated*, in order that no phosphoric acid may combine with the alkalies present, and the alkaline phosphate, formed, be unavailable for fertilizers.

The amount of the phosphoric acid, to be used, may be determined with sufficient accuracy, for the present purpose, by mixing a measured volume of the juice, to be treated, with the phosphoric acid, to be used, as long as there is formed a precipitate of tribasic phosphate of lime. The apparatus, necessary for purifying sugar, by this method, is of a simple nature, and consists of a mixing vessel for mingling the juice, and the phosphoric acid, and a tank, in which the precipitate may settle. After standing a sufficient time, the supernatant clear fluid is drawn off, and the pasty residue

squeezed out in a press. The residue, from the press, makes an excellent fertilizer, and it can, probably, be used with advantage to feed young cattle to promote the formation of bone, and so conveyed to the fields as a manure, after its passage through the animal economy.

By freeing saccharine juices from lime the following advantages are gained :—

1st. Freeing the juice not from lime alone, but from certain organic matters, precipitated with the lime.

2nd. Diminished production of molasses, on account of the lessened percentage of matters not sugar, and diminished alkalinity.

3rd. Easier boiling of the juice, and hence, higher attainable concentration, and greater yield of sugar.

4th. Purer taste of the products.

5th. Consequent avoidance of giving the work of removing the lime to the bone-char, whereby the coal remains longer active, in its other functions; and

6th. Economy of acid, in restoring the bone-char.

A treatise on the preparation of phosphoric acid, for the foregoing use, forms the conclusion of this paper. To this end, superphosphate is systematically washed with water, in open wooden tubs, best lined with lead, and in this way, a tolerably concentrated solution obtained, which contains, as a principal ingredient, phosphoric acid, with a certain amount of sulphate of lime, and which is applied direct, when the presence of gypsum is disregarded. The sulphate of lime may be removed, in great measure, by the evaporation of the crude phosphoric solution, in flat lead pans—the gypsum separating upon concentration. Farther, the solution of phosphoric acid may be made absolutely gypsum-free, by the use of tribasic phosphate of baryta, prepared, by mixing the crude phosphoric solution, with a corresponding amount of chloride of barium, dissolved in water, and neutralizing with soda, potassa, or ammonia. The phosphate of lime, in the concentrated acid solution, can easily be removed by sulphuric acid. —*Zeitschrift für Zucker Industrie*, Jan., 1874.

SOCIETY OF ARTS.

On Friday evening, a paper on "Sugar" was read by Dr. Griffin, who described, at some length, the structure of the sugar-cane, which may be seen in full growth, in the *Victoria regia* house at Kew Gardens. He also dwelt on the manufacture of raw sugar, throwing on a screen, by means of the electric lantern, a series of photographic views. In speaking of the geographical distribution of the cane, he mentioned that Dr. Livingstone found it largely cultivated along the Zambesi, and showed a sample of sugar made in our latest acquisition, the Fiji Islands, which may some day yield us a supply. The culture of the sugar-cane is rapidly extending in Southern Australia, which displayed excellent sugars in last year's International Exhibition, but the whole yield will be required for consumption, in the colony itself, for some time to come. On the Continent, the greater part of the sugar, consumed, is made from beetroot, the manufacture reaching last year the immense total of 1,142,896 tons. This sugar is contaminated with nitrogenous matters, which induce fermentation, and all kinds of chemical changes, and is saturated with an essential oil of a most offensive glue-like smell, very difficult to get rid of entirely. Unfortunately, we import considerable quantities of this raw beet (last year 26,000 tons) to mix with, and deteriorate, the more wholesome and palatable cane-sugars, which are so abundantly supplied to us by our colonies and commerce. Since raw sugars vary greatly in their saccharine richness, which ranges from 70 to 98 per cent., their accurate valuation is of great importance to the refiner, and the lecturer described minutely the optical and chemical methods of analysis, and the precautions to be observed. He gave the preference, on the whole, to the former, and, in illustration of its principles, showed a variety of effects with Browning's electric polariscope. After speaking of the results of experts, which are not always to be implicitly relied on, he instanced one, by a commercial tester, a druggist, and which would be ludicrous, were it not pitiable, also one by a public analyst for food and drugs under the Adulteration Act. Besides its value, as a palatable adjunct to

our food, sugar is important in a dietetical point of view. It is a valuable respiratory element, and is undoubtedly fattening. One of the benefits of the abolition of the sugar duty will, probably, be the large consumption of the inferior kinds by the agriculturist for the fattening of stock. It is of consequence that we should clearly understand the relative advantages, and drawbacks of the different forms of sugar. Raw sugar, which is most favoured by the grocer, is decidedly objectionable, unless of the very finest quality, and it is so mixed and manipulated that it is difficult to make sure of that. It contains considerable quantities of woody fibre, gritty sand, sporules of fungus, nitrogenous matter, treacle, and colonies of the sugar insect. The latter is the most obnoxious impurity, for it is difficult to kill even by hot water, and burrows under the skin, like the itch-insect, which it greatly resembles, having eight jointed and spiny legs, armed with formidable hooks. Dr. Hassall found it in 78 out of 83 samples of brown sugar, purchased in London, and in many in considerable numbers; and Dr. Cameron, the able and indefatigable sanitary chemist of Dublin, estimated that a sample of the sugar supplied to one of the workhouses there contained at least 100,000 insects to the pound. Hassall considers brown sugar, in general, unfit for human consumption, and Cameron states that no one aware of the nature of the impurities abounding in it could use it, without a feeling of loathing. Dr. Griffin then gave various illustrations of the purifying of substances by crystallization, previous to describing the most perfect form of sugar, namely, "Crystals," first introduced to the market by Mr. Finzel, of Bristol. These were described as being as pure as the force of nature, controlled by art, could render them—a purity difficult to match among artificial products. Careful analyses, by Drs. Hassall and Cameron, and the lecturer himself, showed that the total foreign matter was less than a thousandth part, most of which were traces of superficial moisture. For all practical purposes, Finzel's Crystals were absolutely pure, but the same could not be said with equal confidence of loaf sugar. From the small size of the grains, their surface is comparatively great, and they are aggregated into a porous mass of small cells,

like a sponge, so that it is practically impossible to cleanse them, so perfectly, as the centrifugal machine, patented in 1849 by Mr. Finzel, does, for his bold, hard crystals. Hence loaf sugar retains traces of uncrystalliazble impurities, and, amongst them, of those nitrogenous matters which cause fermentation. Their absolute weight is small, but they are active for mischief, just as a particle of putrescent matter, which may be introduced on the point of a lancet, may set up fatal blood-poisoning in a healthy subject. Syrup is an admirable preventative medium, alike for animal or vegetable substances, but it must be pure. Brown sugar, used in preserving fruit, will cause abundance of frothy scum, and the jam will be apt to ferment and spoil. The inferior kinds of loaf sugar produce the same effect in a lesser degree, whilst pure crystal sugars are found to give greater economy, at starting, from their high sweetening power, and far more permanence in keeping. Moreover, the bulk of the lump sugar, now offered in shops, is made abroad, chiefly in France, and sold to us at a much lower price than in their own markets. This was made from a mixture of cane and beet sugars, and some samples, when dissolved in warm water, smelt like the bilge-water of a ship. The lecturer, speaking, as a scientific man, from his own experience, and without any personal bias, would say, emphatically, that pure crystals should entirely replace the old-fashioned loaf sugar. In conclusion he showed, upon the screen, some photographic views, taken in the gigantic Counterslip refinery of Messrs. Finzel, the most extensive one in the kingdom, producing annually 60,000 tons of sugar, and the one object of interest in the decayed and stagnant old town of Bristol. While so doing, he succintly traced the sugar, from its being hoisted in casks from the trucks, in the raw state, till it issued forth from the works a beautiful and a perfect product.

New Caledonia.—The soil of New Caledonia is said to be well suited for the cultivation of the sugar cane, and we learn from the letter of a French colonist there, that the sugar industry is rapidly developing. A Company was formed, in 1869, to establish a manufactory on the river Tamon. Considerable difficulty and delay have been experienced in the transport of machinery, &c. to such a remote region; but in the end of 1873, the works were completed and commenced operations. Seven other factories are already in course of construction.—*English Mechanic.*

CHEAP WINES,* FROM THE PHYSICIAN'S POINT OF VIEW.

From "*The Times.*"

In these days when "rivers of strange wine" are pouring into the country for our consumption, and when the taste for wines of the cheaper and lighter description is rapidly supplanting that for the more alcoholised port and sherry, a safe guide to the comparative virtues and dietetic properties of the former cannot but be reckoned as a public boon. In some 180 pages, Dr. Druitt, who is one of the ablest of our London physicians, and who is known as having for years past made the subject of dietetic value of cheap wines almost his own, now gives us the additional experience which he has gathered during the last eight years concerning these wines. Our author has a facile and lively pen, so that the book is written after an interesting fashion, the more so as the scientific points dealt with are clothed in language at once intelligible to the general reader. The book professes to be a second edition, but in reality it is composed almost entirely of new matter, and on that account we make it the subject of special comment. "Cheap" is a term which invites

* Report on the Cheap Wines from France, Germany, Italy, Austria, Greece, Hungary, and Australia; their Use in Diet and Medicine. By R. Druitt, M.D. Second Edition, re-written and enlarged. Small 8vo., p.p. 180.—London: Henry Renshaw, 356, Strand.

criticism. But, in truth the greatest luxuries consist really of things which are of themselves cheap enough, but which, if perfect of their kind, give us half the comforts of our life, "Man is an odd animal in this respect. How absurd to see tasteless and second-rate bread, bad butter, and bad potatoes even in houses where the expenditure in unnecessary luxuries is extravagant—where, perhaps, some particular Port or Madeira, or 'Chateau Something' at fabulous prices, is the boast of the cellar, but where they can't pour out a tumbler full of decent ordinary claret at luncheon." Wine may be cheap and nasty, but it may also be cheap and good, and the main object of our author is to hold up to public view the evil effects of the use of fortified wines, such as "the hot strong sherries supplied at many hotels and used in many families," and the beneficial effects of re-placing these at the table by the lighter and unbrandied wines which can now be obtained at moderate rates. The subject is dealt with from the physician's point of view in the main, the author keeping constantly before him the difference between pure wine and distilled spirit, showing how the addition of the latter to wine affects and injures the wine.

This advocacy of the larger use of the lighter wines is fairly based upon the ground of sobriety and morals. Dr. Druitt, whilst admitting that the young and healthy, who eat enough, need no wine as a daily drink, holds correctly that they might with advantage take the place not only of the heavier wines, but also much of the beer, tea, and spirits consumed "by large numbers of townspeople, who cannot digest the beer suited to an out-door labouring population. The very tea which is so grateful to their languid, pasty, flabby tongues, from its astringent and sub-acid qualities, and which also comforts their miserable nerves, has this intense drawback—that when taken in excessive draughts, and without a due allowance of substantial food, it begets dyspepsia, and that worst form of it which impels the sufferer to seek a refuge in the gin bottle." Cheap wine would cut off, our author argues—and he knows the life of the people, to whom he is referring, as well as anyone—the temptation to gin, and with an equal bulk of water would be

found, in certain cases, a happy substitute for tea. "If," he adds, "instead of half the tea, at the English middle-class breakfast, an earlier luncheon with a glass of light wine were given it would greatly abridge the hours of half-hunger, half-dyspepsia, which many school-girls, shop-girls, and other sedentary middle-class women, in town, suffer between their breakfast and early dinner." All this, we fear, is Utopian until a profound impression for the better be made upon the existing taste of the English mouth for the strong alcoholic twang to which the wine-forger has pandered in every possible way. Who is to effect the desired change if not such men as our author? Of course the only real test for wine is an empirical one; the stomach, not the chemist, must pronounce the verdict for or against, and that which agrees with the former, and not that which comes up to the ideas of the latter, is the real elixir which man should drink. But then comes the question what should be the proper effects of wine on the nerves of taste, and upon the frame at large—in fact, what in the view of the physiological physician constitutes good wine? Dr. Druitt begins to deal with this point in his fourth chapter, after giving a lucid account of the nature and chemical composition, as well as the changes that go on during the fermentation of wine.

The tester will look for the following in wines:—"In the first place, in drinking a good large sip of the wine, does it *prima facie* strike us as being one liquid, or a compound of many? Wine should have an absolute unity, it should taste as a whole. True, we may distinguish various properties on reflection, but they should be as parts of a whole, and not as independent units mixed together. But bad wine resembles what schoolboys of the last generation used to get when ill—a 'black dose.' Here, a something sweet meets one part of our gustatory organs, there, something sour, there something fruity, or bitter, or hot, or harsh, just as if half-a-dozen ill-blended liquids came out of one bottle, with perhaps a perfume atop that seems to smell of a hairdresser's shop.

"Wine should have a certain generosity of taste; unless spirit could be extracted by distillation it would not be wine; but there

should be no smell nor taste of added and ill-combined spirits, nor that heat about the throat which they cause.

"In regard to the kind of sensation which alcohol gives. It is a simple warmth; it does not affect the taste, *quâ* taste—*i.e.*, the power of distinguishing the sapidity of food and drink; but it burns—it burns every part alike by virtue of its physical qualities, and the sensation produced by it is not peculiar to the sense of taste, but common to the whole body. It burns lips, gums, hard palate and throat, just as it does the parts of the palate specially endowed with taste.

"Wine, like all drinks used by healthy grown-up men, is slightly sour—not even excepting water, if it contain a palateable quantity of carbolic acid and dissolved chalk. All soft, neutral, or alkaline drinks are, like milk, adapted for infants, or, like seltzer water, for invalids, or for people past their grand climacteric, or for the gouty. But all the drinks of healthy men and women are sour, such as tea, coffee, ale, beer, cider, mum, mead, perry—every kind of fermented drink known to the law, including wine, of course, and all the fruits which bountiful nature gives us. So, too, are meat and vegetables in a lesser degree; flesh, fish (less so), bread, and horse-radish, the potato, the carrot, and the like. Nature abhors alkalinity."

Now, this is not the idea entertained by the public, who have been artificially educated to another opinion. Of course there is an acidity or sourness which is wrong, an acetous acid which belongs to the vinegar bottle. We are speaking, however, of the natural acid of the wine, which belongs to that which is perfectly fermented, and which in young wines is due to the presence of the tartrates that are deposited by age. The natural wine acids do for the palate what soap and water do for the skin: make it clean and active for work. In the St. Elie this acidity, for instance, is well marked, and says Dr. Druitt of it, "Blessed is the young wine that has these characters, if it can only be put by, to mature." It has been the habit to mask these tartrates by the addition of spirit, sugar, gypsum, and the like, hence the cause of multifarious adulterations to suit a vitiated taste. The list of wines, adulterated

after this fashion, includes the Hambro' sherries, the commoner sherries and port, the strong sour clarets that taste of added spirits, and such like. The character of sweetness, "of stability, a clean, round, firm, perfect taste," of astringency, of body, of odour, and the power to satisfy, are not left out of account in our author's remarks. But wine, to be good, must have another quality—it must satisfy.

"A man must feel that he has taken something which consoles and sustains. Some liquids, as cider and some thin wines, leave rather a craving, empty, hungry feeling after them. To wine, above all other kinds of food, we may apply the phrase of the Hebrew poet, 'It satisfies the hungry soul, and fills the empty soul with goodness.' Amongst the senses, we ought to reckon the consciousness of hunger, emptiness, and exhaustion; and of the opposite—comfort, fulness, and well-being. Dr. Edward Smith, in the course of observations on the effects of food, notices how, when a man is intensely hungry, an innutritious food, such as arrowroot, which does not supply the real material wanted, is tasted with disgust or nausea, whilst a bit of bread, the true staff of life, the moment it is bitten and tasted, seems to create an instant feeling of comfort and satisfaction that is felt down to the ends of the fingers. There is a sense, in the whole body, that the exhaustion and emptiness are in the way of being relieved. So it is with wine. Before even it has reached the soft palate, so soon as it is felt by the sense of touch upon the lips, there seems an electric telegram, diffused over the remotest twig of every nerve, that a something has come to sustain a feeble heart, fill empty veins, feed and vivify an exhausted brain, and make the work of life go smoothly."

Such, in short compass, are the ideas of a good wine from a dietetic point of view, and the desiderata, indicated, exclude, as comparatively unwholesome, the stronger fortified liquids, which, in fact, contain fermentable matter held in check by spirit, and are thus, potential agents in the production of gout.

So far for wine in the abstract; a few words may be added in regard to wines in particular. Dr. Druitt, in speaking of the

Bordeaux wines, whose praises were loudly sung by the poet Ausonius some 1500 years ago, affirms that when perfectly fermented, as they mostly are, and free from sugar and other material likely to undergo imperfect digestion, and provoke gout and headache, they are admirably adapted for children, literary persons, and all whose occupations are chiefly carried on indoors, and which tax the brain more than the muscles. They make good blood and favour the purification of the system. He adds—

"I put together three classes of patients—rheumatic, gouty, and bilious, because they are the chief sufferers from heavy illfermented, alcoholised, and ill blended beers and wines. I have no theories; but state the fact that persons whom I have attended for years enjoy good health whilst they drink pure Bordeuax wine, and suffer in head or joints the moment that they touch port or sherry, unless of the dearest and oldest qualities. Practitioners of the last generation used to be haunted by the demon acidity, and to think they could cast it out by diet of meat and brandy. I say, try claret, and you will add ten years to your patient's life and to your own fees.

"I would that my voice could reach the British tradesman. I don't mean the personage who lives out of town and drives into his place of business in a brougham, but the genuine, old fashioned, portly fellow who stands behind the counter all day, stays indoors all the week, drinks beer at his one o'clock dinner, and gin or brandy-and-water at night, makes up his books on Sunday mornings, takes an hour or so of fresh air between one and three, and then devotes Sunday afternoon and evening to a good dinner, with a bottle of port; has, perhaps, as Charles Lamb said, a bit of sausage with his tea, and a little something warm and comfortable at night. When I look at the enlarging forms of these honest fellows, and think of their food as compared with their work; and further, when I think of the frightful mortality amongst them in cold winters from 'bronchitiis'—(say, rather, from a blood too thick and a heart too flabby)—I cannot help thinking that if the maidservant were to fetch a bottle of *vin ordinaire* from the cellar

instead of a pot of beer from the public house, for the family noon-day repast, and if it were substituted for the ginnums-and-water at night, our too solid tradesmen would have a more useful liver and lights under his ample waistcoat, and would not be so nearly liable to

"Fall as the leaves do, and die in October."

It will be a good day for the morals, health, and intellectual developement of the English when every decent person shall, on all hospitable occasions, be able to produce a bottle of wine and discuss its flavour instead of, as at present, glorifying in the strength of his potations.

"One thing that would go, with the greater use of Bordeaux wine, would be the custom of drinking it in its proper place, during dinner, as a refreshing and appetising draught to entice the languid palate to demand an additional slice of mutton. Physicians who practise amongst town children of a class in life where prevention is looked to as well as cure, know well the capricious and feeble appetites of many children; how they cut off the fat and brown, and how they reject every morsel at all under-done. Be the case what it may, childrem must have quantity and variety of food. If not, if the parents content themselves with that slovenly surveillance of servants, who report that Master Johnny is a remarkable child, quite healthy, but won't eat his meat; or that Miss Jeannie is plump, and so strong that she takes and requires as great a dose of aperient medicine as a grown man, and that she loves bread and butter and sugar better than meat; then comes an age—say 14 to 17—when the teeth are found to be decayed, or when the boy or girl is said to have a 'delicate chest,' and must go to Torquay, or the young lady to some chalybeate water, and all those other horrors too well known to parents of 'delicate,' *i.e.*, underfed or appetiteless children. Much of this might have been prevented, puncheons of cod-liver oil might have been spared at the age of 16—20, if, at the age of 7—10, the governess had said, 'Miss Jeannie won't eat her mutton,' and if the physician had said, 'Give her some kind of light, clean-tasting, sub-acid wine—Bordeaux or Hungarian—let her sip this, *ad libitum*, at dinner, so that it may tempt her to relish her mutton.'"

And he concludes :—

"What a boon it would be to the flower of our female population, if the medical profession were courageous enough to set at defiance all the army of Mrs. Gamps who infest the lying-in chamber, and who insist on cramming young mothers with the heaviest beer or porter, brandied wine and ardent spirits, on the pretence of keeping up their strength and assisting them to nurse! If ever there were a fit machinery for making women drunkards, it was the whole organisation of the lying-in chamber, as it was when I first knew practice, and even that was an improvement on times gone by. A poor woman, after the pains of childbirth, was loaded with bed-clothes, and carefully shut out from fresh air and denied wholesome ablutions, in order, as it was said, to keep out the demon Cold. She was starved, denied a slice of roast mutton, or any solid food, and saturated with gruel and other fearful slops in order to propitiate the demon Inflammation. Fruit and vegetables were denied, because of the belching demons Acidity and Wind. Then, when duly softened, sweated, blanched, puffy, nerveless, and breathless, she was exhorted to take stout or ale and port wine to keep up her strength and make milk for the little one. How soon young women get a bloated look and lose their youthfulness, under this *régime*, every man of observation knows too well. But it is not so well known that in humbler circles, where no port wine is to be had, the gin bottle was and is the substitute. Talk of mission women! Low monthly nurses are the very missionaries of ardent spirits."

We have not a solitary word of exception for these opinions of our author.

Of the value of Burgundy—which, however, in many instances might well have more care expended in its preparation—in the debility of nervous exhaustion there is no doubt. As regards the Moselle still wines, it must be said that many are somewhat acid, lacking in body, and often artificially flavoured with elderflower water; and it is difficult, on account of the expense, to place these wines within easy reach of the public, but, if good, the physician knows well enough that "they favour appetite, exhilarate without

producing heaviness and languor afterwards, and they purify the blood." As for the Hocks, though the cheaper—15s. to 30s. a dozen—they are to the "grander sorts as a whistle pipe to a church organ," yet they are wholesome, and Dr. Druitt remarks that it is easy for neighbours to "co-operate" to get them.

"The squire, the parson, the doctor, the lawyer, the retired officer, and the widow of a limited income in a country village, instead of sulkily ordering fabricated sherry by the dozen, should combine and have in, an aum of Hock, a hogshead of red Bordeaux, and one of white Burgundy, and should bottle and divide the product."

Of the Swiss and Italian wines more knowledge is required. The Greek wines, however, find especial favour with Dr. Druitt.

The taste for these and other wines is, with many, not readily acquired, but is a safe investment to get, as the experience of those who now like these wines abundantly shows. The Hungarian wines likewise receive a warm commendation from our author as being especially nutritious; and markedly so is this the case, with the Ofner and the Carlowitz, which are now largely prescribed by physicians for weak, enfeebled, and bloodless men and women. Dr. Druitt, in speaking of the Austrian wines, has a reply to the question often put to him, "It is all very well to bring these cheap wines under public notice, but if the public demand increase, will they not cease to be cheap, for the demand will be greater than the supply, or else adulterations and dilutions will go on rapidly?" He calls attention to the ability of the Austrian vineyards at Vöslau, if their proprietors were stimulated to utilise them more freely, to supply any deficiency that might be created by failure, on the part of France, Germany, and Hungary. But we must bring these remarks to a conclusion, without referring to the sparkling, the Australian, and other wines. We presume no one, who has gone into this wine question practically, will deny the desirability of supplanting the alcoholised wines in common use by those of a purer a more wholesome description by "the sumptuous Burgundy, the graceful Bordeaux, the nutritious Hungarian, the sturdy Australian, the

robust and wit-compelling Rhenish." The prevailing taste for alcohol has not only exerted a "debasing influence" on wine-culture, enabling "wine forgers to concoct any variety of fictitious liquids, which the public will buy if strong enough," and at exorbitant prices; but the use of these fortified wines accounts for a multitude of "ills which flesh is heir to." This is not a quarrel against certain veritable old wines which have the smack of the true wine flavor about them. The remarks, however, are only too true of the majority of cheaper ports as well as cheaper sherries now drunk by the English. When M. Assolant visited England, some little time since, he caused great offence, it is said, by describing the English "Miss" as fond of brandy. No wonder he did so after tasting the sherry she drank. Dr. Druitt would have her taught to recognise, gifted as woman is with perceptivity of odours, what the true juice of the grape and its bouquet are; he would have the lower orders less content with the "hot sensation of spirits which is their delight;" and he would have both discover, by experience, that the change paid them, in the long run, immensely, in a greater freedom from disease, debility, *et hoc genus omne*. And now, if any of our readers wish to put their likings to the test, let them follow one of the author's prescriptions, as follows:—"For a small party of friends, who really want to dine seriously, they may, if they choose, begin with a thimbleful of sherry or Madeira; next with fish and entrées, a good white wine, Grave, Pouilly, Niersteiner, Scharlachberg or Œdenburg, St. Elie or White Auldana; with the roast, the best red wine in the house, Volnay, Côte Rotie or good Bordeaux, Assmannhauser, Red Vöslau or Gold labelled Ofner or Naussa; then some sparkling wine (this should be handed to the ladies throughout); at the end of the dinner some fine Rhine wine or Bordeaux. Then coffee, clear, hot, and black." But let no one who is anxious for sound information on the general question fail to read his book, which is as pleasantly as it is sensibly written.

Correspondence.

To the Editor of "The Sugar Cane."

Sir,

From time to time, there has appeared, in your excellent periodical, articles on sugar machinery, of more or less interest. I have lately also come across a pamphlet which treats of special machinery erected at Aba el Wakf, in Egypt, with discussions on the same. The reading of the various papers, referred to, have led me to compare my own experience in the matter, embracing a period of fourteen years' constant practical connection, as engineer, with a number of sugar estates.

The diversity of opinion on sugar machinery, held by gentlemen of undoubted mechanical and scientific knowledge, can only be accounted for by supposing that the want of time and opportunity, to make the necessary experiments, has prevented the majority arriving at correct conclusions, as to the best proportions for a good mill. Several examples, showing the superficial way in which this matter is treated, may be found in the pamphlet here referred to, such as asserting that the rolls of the Aba el Wakf mills, at speeds varying from 18 to 36 feet per minute, gave equally good results. Had the author of this assertion made direct experiments, on the extraction of these mills, he would have found a considerable loss of juice, at the higher speeds. Also, if the gentleman who states the average extraction of cane juice in the West Indies to be, from 75 to 80 per cent. of the weight of the canes, would give the question closer attention, he would find himself greatly in error. The average extraction in the West Indies does not reach 65 per cent., and the average extraction of the largest, and most carefully-fed mills, is about 70 per cent. They are equally in error, those gentlemen who recommend rolls of small diameter, great length, and high speeds. Without entering further into the matter at present, I subjoin a table, giving the results of a large number of experiments, made on different mills, and particularly call attention to the mill lately erected on the estate "Mercedita," property of Dr. Juan Serralles.

TABLE OF EXPERIMENTS ON SUGAR CANE MILLS.

Name of Estate.	Motive Power.				Crushing Power.		Combined Results.					Quality of Cane.		
	Diameter of Cylinder in inches.	Stroke in inches.	Speed of Piston in feet per minute.	Pressure of Steam in lbs.	Dimensions of Rolls in inches.	Speed of Rolls in feet per minute.	Lbs. of Canes ground per hour.	Gallons of Juice per hour.	Percentage of Fibre in Canes.	Percentage of Juice extracted.	Percentage of Juice lost in Megass.	Average diameter of Canes in inches.	Average weight of Canes per lineal ft. in oz.	Degree Beaum of Juice.
Isabel	$15\frac{3}{8}$	42	350	50	48 × 24	24	17800	1000	11·5	62	26·5	$1\frac{1}{2}$	16	$11\frac{1}{4}$
Estrella	14	36	300	50	54 × 24	23	17500	1000	11·5	62	26·5	$1\frac{3}{8}$	15	11
Mercedita 1..	$15\frac{1}{2}$	30	360	55	48 × 24	24	20400	1200	13	63	24	1	12	10
Aguas Prietas	14	36	300	45	54 × 24	22	17500	1000	11	63	26	$1\frac{5}{8}$	17	$11\frac{1}{4}$
Teresa	16	36	300	50	48 × 28	20	20600	1200	13	64	23	1	12	$10\frac{1}{4}$
Constancia ..	14	42	245	50	48 × 26	20	16800	1000	11·5	65	23·5	$1\frac{3}{4}$	16	12
* Mercedita 2	14	42	350	60	54 × 36	10·5	25700	1800	13	75	12	1	12	10

This mill, with inferior canes, and low motive power, gives the highest extraction of any mill of which I have authentic record. The good results obtained from this mill are entirely due to the large diameter, and slow speed of the rolls. The speed, I believe, to be the slowest of any steam mill yet erected. The average extraction, as shown by a great number of direct experiments (that is, by weighing the canes and the megass obtained from them), is 75 per cent. Indirect experiments (that is, taking a quantity of megass, weighing it, having it thoroughly washed and dried, then calculating the extraction by Dr. Icery's formula), of which a great number have been made, corroborate the above results. An armful of megass, taken from the whole breadth of the megass elevator, weighed when fresh 18 lbs.; after being washed and dried it weighed 9 lbs., which is equal to 74 per cent. 4 lbs. of fresh megass give, when washed and dried, 34 ounces, which is equal to 75·5 per cent., the woody matter in the cane, in both cases, being 13 per cent. The method I adopt is as follows:—The megass is taken as it leaves the mill, and the weight noted; it is then steeped in hot water for some time, well rubbed, washed, and wrung out; it is then put in the sun to dry for three or four days, until two successive weighings, with an interval of twelve hours, show no loss, which proves it to have parted with all moisture. During the operation a small quantity of fibre is unavoidably lost, which causes the yield shown to be a little under what it actually is. With a heavier feed of canes, this mill has given, on various occasions, over 80 per cent. yield. Besides the gain in extraction, the work done is considerably more than that done by mills of the general class, having equal motive power, as may be seen by the annexed table of experiments. The engine and boiler, connected with this mill, had been in use on the estate before, and are altogether too small; with an engine and boiler of proportionate power, I conclude, from the results already obtained, that the average yield would not be under 80 per cent., and the work done 50 per cent. more than at present. The advantage of short rolls and large diameter may be summed up as follows:—The greater the diameter, the greater will be the "bite" of the

rolls—that is, they will receive a larger amount of canes without choking, and the canes will be longer under pressure; short rolls facilitate their being equally fed throughout their length. The megass will not be broken up so much, while the extraction will be much more than when rolls of less diameter are used.

A slow speed prevents loss, by allowing the juice time to fall away from the megass, preventing its being sucked up by the megass after pressure. Rolls of large diameter, with correctly proportioned gearing, will require less power to do the same amount of work than rolls of small diameter, *vide* table. This machinery was made to my instructions by Messrs. W. and A. McOnie, of Glasgow, and, for design, material, and workmanship, is considered by a number of gentlemen, practically acquainted with the working of sugar mills, who have examined it at work, to be the most superior article of the kind they have yet met with in the West Indies, and reflects great credit on the manufacturers. The system in use on this estate, for reducing the juice to sugar, I may enter into in detail at some future time; for the present I may say that it is reduced to syrup in an improved system of open pans, then precipitated and finally reduced to sugar in the Wetzel pans. Megass, with a slight addition of dry trash, is all the fuel required for all purposes. The sugar is of excellent quality, and equally as good as when the canes are ground by the other mill, extracting 63 per cent.

Yours truly,

Robert Graham.

Ponce, Porto Rico, May, 1874.

* The average depth of canes, on cane-carrier, of this mill was 12 inches during the experiments, the carrier never being stopped on account of heavy feed. On the others, the average depth of cane was from 2 to 4 inches, but the carriers had to be frequently stopped to avoid bringing the engines to a standstill, men constantly standing by for that purpose. I have given the number of gallons of juice, per hour, in round numbers; the actual result varied a few gallons more, or less, in all cases. R. G.

PLANTING IN PORTO RICO.

TO THE EDITOR OF "THE SUGAR CANE."

DEAR SIR,

The following account of work done on a Porto Rico estate, and the mode of proceeding, may prove interesting to some of your readers.

The engine and mill are American, from West Point, as was most of the machinery introduced twenty-five years past; at that time, this mill was considered a powerful cane crusher, the rollers are 4 feet long by 2 feet diameter, the cylinder of engine 15⅜ in., stroke 42 in., and when well supplied with cane the extraction is 62 per cent., giving 1000 gallons of juice per hour.

Engines and mills introduced of late years, from Great Britain, are much superior, their general average of extraction is 68 to 70 per cent., but one, recently mounted here in Ponce, by Robert Graham, Esq., C.E., is of a much superior class, giving an extraction of from 75 to 80 per cent.; the rollers of this mill are 4 feet 6 in. long by 36 in. diameter, and the weight of mill and gearing about 80 tons; it is the most effective mill, as yet, introduced here, although there are some considerably larger.

Here, from the mill, the juice passes, through a coarse strainer to the sulphur apparatus, this is of Colonel Stewart's patent, a box 8 feet long by 2 feet broad and deep, with a shaft driven by belting connected with the engine; this shaft revolves the drum and paddles, making about sixty-five revolutions per minute, and keeps the juice in a state of foam as it passes through the box; the entrance hole for the juice is 8 inches long by 4 inches deep, the exit, at the farther end, is 6 inches by 4 in., having a piece of movable board 1 in. high, let into the bottom of the canal to raise the juice on the paddles. The supply of water, for washing the gas, is constant and good, as is also the steam-jet.

There are two furnaces for burning the sulphur, one close to the apparatus, this is only used the first few hours of putting

about, the one most constantly in use, is that placed on the top of the arch, in front of the boiler; in building this, we let in a small plate of half-inch iron, and built a small dome over it, this has an opening at the side to permit its being cleaned, a hole at the top, to introduce the sulphur, and the fumes pass out at the side, through an earthenware tube, to the washing box encountering, on its entrance to this, a shower bath, from this the gas passes on to the liquor box into which it is injected with the aid of a jet of steam.

The juice, as it leaves the sulphur apparatus, is thoroughly strained and immediately pumped up to the receiving boxes, containing, each, 1000 gallons a "strike," allowance being made for the space occupied by the cush and sediment, after drawing down to the coppers, the clear liquor, the sediment is drawn off to a box below, strained and settled, and the liquor returned to the boxes, the boxes being well washed each time emptied; for this purpose, and to supply water to the heaters, and to all parts of the buildings, a large iron tank is placed at a considerable elevation, near, and inside, the roof of the engine room.

All this part of the arrangement is exceedingly well combined; everything works smoothly, the juice well strained and subsided. Where pumps have to be used, to raise the liquor to the coppers, it is found more advantageous to pass the juice through the sulphur apparatus, prior to passing it to the pump.

I am aware there are persons prejudiced to the use of sulphurous gas. I know many who were particularly unsuccessful in applying it, and no doubt seriously injured their sugars, and pockets. I have seen sugars, made by a good sugar boiler, but a novice to the use of sulphur, turn perfectly green, yielding also molasses of a dark greenish tint. On many estates here, the system was thrown aside, not only as useless but prejudicial, but fortunately, as far as this island is concerned, there were men who have the perseverance to try and remedy matters, and the result has been a perfect success. All our best sugars are made with the assistance of sulphurous gas, and the improvement is so

evident, no planter would, to-day, here in Porto Rico, attempt to gainsay it.

It requires some practice as well as experience, as a sugar boiler, to use sulphurous gas. The gas must be well washed, and injected into the apparatus by a strong jet of steam. The liquor, being lifted by the paddles, during its progress through the box and continually falling in the shape of heavy rain. The liquor, steam, and gas, incorporate, and, at its exit, the temperature of the liquor is raised to over 100° Faht. and has a sensible flavour and smell of sulphur; placed in a glass it separates freely, and immediately, from the cush and other light impurities, these rising and forming a thick scum on the surface, the liquor below remaining perfectly bright; the same effect is produced in the settling boxes, the liquor is drawn from them perfectly transparent. There is no fixed rule for the quantity of sulphur applied; like lime, it depends on the quality of the juice; in good juice one ounce to each hundred gallons will suffice, in bad, it may take as much as three, sometimes, even, four ounces to the same quantity of juice. I am not aware there is any test to regulate the quantity, the practical sugar boiler never mistakes; he detects, at a glance, if too much or too little gas is being applied, it can be seen the moment the juice leaves the apparatus, and in all the subsequent stages of the process of concentration. Sometimes the belting which drives the drum gets out of gear, or the apparatus itself out of order; not to stop the work one or two strikes may be made without the sulphur, but these are always an eye-sore; the difference in the colour of the juice, its difficulty in separating from the cush, the dark colour of the syrup, both in taches and evaporators, and want of firmness of grain in the coolers make such strikes always evident.

The use of sulphur requires quick concentration, the greenish tint, I have seen, in some sulphured sugars, I attribute in a measure to slow boiling coppers, but more particularly to irregularity in the supply of water to the washing box, neither do the fumes of sulphur incorporate well with the juice, unless a good supply of steam is injected with it.

Sulphured liquor requires more lime than juice in its ordinary state; moreover, it must be applied differently. Time should be given to assist the separation of the impurities; again, as soon as the thick scum is removed, and previous to ebullition, the liquor should be tempered a second time, and, sometimes, even a third time. This is where unpractised hands err; they remain satisfied with their first temper, and the result is clammy sugar.

Sulphured liquor, well tempered, produces a brighter and harder grained sugar, less molasses, and this of a superior quality. The sugar is not so liable to deterioration or to the attack of the acari; it will keep, from crop to crop, without acquiring any unpleasant flavour, and persons, accustomed to use such sugars, find an unpleasant flavour in others. Sulphured sugars, well made, have more the taste of sugar candy.

At first, it was supposed, sulphurous gas caused the cane juice to ferment more readily than it naturally does; this is not the case. Sulphured juice requires merely more lime and some practice in tempering it. I may cite, as an example, the day we commenced crop. After grinding one copper of liquor, and of course previous to changing fire, the engine pump gave out; we were thirty-six hours before repairs were effected, yet, on testing the liquor, ground the previous day, no acidity was found, neither did I notice any difference in the quality of the strike of sugar made from this liquor. With our new system of taches, each strike is boiled to syrup separately, so the least difference in colour is noticed; moreover, I think by the time the juice is concentrated, to syrup, no trace of sulphur remains; it has worked off in the scum and steam. That none remains in the sugar is evident from the following analysis, neither do I think sulphur causes any greater incrustation of lime, on taches, or wetzel pans evaporators; on the contrary, since I have used sulphurous gas, I am inclined to think the incrustation on the wetzel pans evaporators is less.

"I have examined a sample of sugar marked Nil, and find the following to be the result:—

Crystallizable sugar	98·43
Uncrystallizable sugar	·10
Unknown organic matter	·32
Mineral ash (carbonate of lime)	·15
Water	1·00
	100·00

This sugar was carefully examined for sulphur, but it was found not to be present in any form."

(Signed) G. H. DYTON.

The liquor is reduced to syrup in the taches, drawn off and settled, and then pumped up to the wetzel pans, and from these, the sugar runs to the coolers, which are on the second story of the curing house. This arrangement facilitates the potting. The sugar is shovelled out of the coolers, through spouts, to the hogsheads below, and, by a little care in calculation, it is seldom necessary to use pails, and, when used, the distance to carry them is short.

The leading feature of this arrangement is the Balseyro battery, a new system of concentrating cane-juice to syrup, for which we have patents for both the Spanish islands.

On entering the boiling house the most striking point is the portico, if I may so call it, of the taches, the flooring in front is raised some four feet above the pavement; from it, to the right, are the steps leading to the wetzel pans and coolers, and, to the left, others which lead to the platform or balcony, in front of the coppers, to engine; beneath this balcony are the filters for the skimmings, and above it, extending, from water tank and liquor boxes, to the wetzel pans, is another balcony: the whole work can be inspected from any part of the boiling house or balconies, and these facilitate the easy superintendence of every department.

I do not at all pretend to insinuate we have arrived at the *ne plus ultra* of sugar making; we have adopted the Balseyro battery for the defecation and concentration of juice to syrup, and, with the material we had on hand, have made a most complete arrangement, which does easily a good deal of good work: for instance,

we made, in five days, seventy-three hogsheads sugar, whereas, last year, in the same number of hours, we could never pass fifty ; last year the mill was always in advance, this year we could concentrate more liquor would the mill give it.

The Balseyro battery is a peculiar arrangement of two taches, having two furnace mouths, and, on an upper story, two grand coppers, each of these is worked separately, cleaned by patent skimmers, worked on axle and wheels, running on the upper wall, the skimmings from each is drawn off to canals in front, and run down to the filters below. The liquor, when required for the taches, is drawn off through valves and run off spouts.

Between the taches there is no saddle, the liquor boils from one to the other; these are surrounded by mason work, on three sides, forming a kind of tank, 14 ft. long by 7ft. 4in. wide, the space in front being filled up, by shifting boards, grooved one to the other, and let into slots of two wooden uprights built in, on either side of the mason work. This box or tank was raised fifty-four inches above rim of taches, but, on trial, we had to raise it twelve inches more, as the liquor boiled over to the stoke hole. It now frequently boils up to the sixty-six inches, and grease has to be applied, although a small quantity, even of this, seriously interferes with the granulation of sugar.

This is the first battery of the kind mounted on the south coast. In Arecibo the inventor, Rafael Balsero, mounted the first one on the Plantage estate belonging to C. F. Storer, Esq. Curiosity induced me to make a long journey to see it, and it struck me as being so peculiarly adapted for the easy concentration of cane juice to syrup, the juice appeared to clear itself so rapidly of its impurities, the general appearance of the juice and syrup was so much brighter than that concentrated in common coppers, that I not only returned several times to convince myself my conclusions were right, but finally induced Mr William Oppenheimer and others to accompany me. They were as much struck as I had been with the simplicity of the arrangement, the rapidity of the boiling, and the brilliancy of the juice. 7½° Baumé was a fair trial for the best hung coppers, and during our visit, a strike was

taken off, every thirty to thirty-five minutes; at 25° Baumé the quantity of raw juice, drawn down for each strike, was 900 gallons.

Mr Oppenheimer, at once, decided on mounting a set on his estate. Planters from all parts of the south coast have visited it. All the practical men are of my opinion; moreover, the immense quantity of dry megass, that has accumulated, attracts the notice of all comers, an evident proof of the small quantity of fuel consumed.

The other arrangements of the boiling-house are simply those within the reach of all practical planters. Mr. William Oppenheimer, an experienced and successful planter; Robert Graham, C.E., many years resident in Porto Rico; and myself, a planter of the St. Vincent school, disciple of Tourama, Mitchell, the little late and early system, the three of us have produced an unique sugar-making establishment at little cost. None of us deny that a vacuum pan and centrifugal would be superior to the wetzel pans, neither do we ignore the addition of three 800 gallon clarifiers. Thus, avoiding the clarification in the coppers and drawing down a smaller strike would be an improvement. These are innovations for a future day; but the question was to remove the old cumbersome battery, introduce a superior mode of doing its work, and use as much of the old apparatus as possible.

Without going to any great outlay, we have succeeded in every respect; there is no hitch of the most trivial nature, everything was foreseen and provided against, and from the time the juice leaves the mill, till the hogshead of sugar is on the cart, every operation is simple and easy; moreover, there is no waste, as, by the Balseyro system, there is no miring of liquor, or skimmings, that from each copper is filtered separately and returned to the copper. The saving of juice is fully six to eight per cent., more frequently the latter than the former. The other advantages of this system are the avoidance of buckets and hand brushers, saving of fuel, immense quantity of liquor, thoroughly defecated, and concentrated to syrup, in a short time, few hands employed, two are sufficient for all the inside work, and small cost of plant.

In many respects the system is superior to that of the triple effect; the only thing that in my opinion can compete with it, for reducing cane juice to syrup, is the Concretor. They both have the same defect; the triple effect has but one advantage, that of using the green megass under the boilers as it leaves the mill. This is all that is required to make both Concretor and Balseyro batteries perfect. Robert Graham and myself have for many years applied ourselves to solving this problem of burning fresh megass as it leaves the mill. From articles in *The Sugar Cane*, I see Mr. Alfred Fryer has dedicated much time to the same object, and until this problem is solved no system can be considered perfect. The triple effect, although it permits the green megass to be at once consumed under the boilers, has so many other defects, which more than counterbalance this advantage; moreover, the consumption of coal in a triple effect factory is enormous, generally cent. per cent. of weight of coal for weight of sugar made, in no instance, that I am aware of, less than eighty per cent., and in many factories I have visited it exceeds this.

Practical men both of us, my partner Balseyro and myself, are sanguine in the further propagation of our system. The unsettled state of the Spanish colonies may prove a momentary check to its general adoption, but several of our Puertruqueno estate owners intend using it next crop.

Richard E. Burton.

THE WEATHER IN FRANCE.

We copy the following observations from the well-informed French journal, to which we are indebted for the first paper in this number of *The Sugar Cane*.

The temperature of the week has been very high, but modified, in its effect, by storms, which have been very beneficial in the localities over which they have passed. The Nord appears to have profited more than the other departments, which, we must hope,

will receive, in their turn, those beneficent showers, which the beet so imperiously demands. Unfortunately, this is but a hope, inasmuch as the rains have not been general, and at the time we write dry weather mostly prevails.

As it happens, every year, the plants are in superior condition, in the departments in which the seed is sown early, among which is the Nord. The month of April, which was very fine, admitted of the first sowings, and was favorable to germination; and those which date from this time, although retarded by subsequent frosts, have profited by the warmth, and are now benefiting by the rain.

As to the sowings of a later period, they have suffered from coldness and drought; and their condition at the present time, especially in localities where there has been no rain, is very sad. This accounts for the inequalities we see in the beet cultivation, very good in one place, middling in another, in a third, total failure. In this aspect of things, we still hold to the opinion, which we every year repeat, that early sowing is invariably an advantage. The only risk attending it is that a second sowing may be necessary, a small inconvenience compared to those which the farmer exposes himself by the contrary practice.

Drought has equally made itself felt in Belgium, but the storms, which have since supervened, have partially improved the beet. The news from Germany and Austrian Hungary is also better. M. Licht estimates the deficit in the sowings at 10 to 20 per cent. for Austrian Hungary, Belgium, and Holland; whilst in Russia, in Poland, in Germany and France, the acreage, under culture for beet, will be nearly equal to that of last year. Whence we conclude that, even with some increase in the returns, the sugar production of next season will only very slightly, if at all, exceed that of 1873-4.

Let us remember that this production, for the whole of Europe, was 1,110,000 tons, against 1,142,897 in 1872-73, 873,280 tons in 1871-72, and 942,589 tons in 1870-71.

STOCKS OF SUGAR IN THE CHIEF MARKETS OF THE WORLD ON THE 1ST MAY, FOR THREE YEARS, IN THOUSANDS OF TONS, TO THE NEAREST THOUSAND.

	1874.	1873.	1872.
Great Britain	254	145	83
France	169	111	59
Holland	54	63	46
Germany (Zollverein)	29	20	23
Six other *entrepôts*	10	8	3
Total in Europe	516	347	214

CONSUMPTION OF SUGAR IN EUROPE FOR THREE YEARS, ENDING 1ST MAY, IN THOUSANDS OF TONS.

	1874.	1873.	1872.
Great Britain	780	708	697
France	252	253	287
Germany (Zollverein)	295	262	182
Holland	28	27	24
Six other *entrepôts*	107	105	109
Total in Europe	1,462	1,355	1,299

ESTIMATED CROP OF BEET ROOT SUGAR ON THE CONTINENT OF EUROPE, FOR THE ENSUING SEASON, COMPARED WITH THAT OF THE THREE PREVIOUS SEASONS.

(From Licht's Monthly Circular.)

	1873-74. Tons.	1872-73. Tons.	1871-72. Tons.	1870-71. Tons.
France	395,000	395,000	335,000	289,000
Germany (Zollverein)	290,000	260,000	189,000	263,000
Austro-Hungary	170,000	205,000	162,000	182,000
Russia and Poland	150,000	150,000	90,000	135,000
Belgium	72,500	80,000	72,000	56,000
Holland and other Countries	37,500	35,000	25,000	17,000
Total	1,115,000	1,125,000	873,000	942,000

SUGAR STATISTICS—GREAT BRITAIN.

To JUNE 20TH, 1874 AND 1873. IN THOUSANDS OF TONS, TO THE NEAREST THOUSAND.

	STOCKS.						IMPORTS.						DELIVERIES.					
	London.	Liverpool	Bristol.	Clyde.	Total, 1874.	Total, 1873.	London.	Liverpool	Bristol.	Clyde.	Total, 1874.	Total, 1873.	London.	Liverpool	Bristol.	Clyde.	Total, 1874.	Total, 1873.
*British West India	..	†	..	..	†	42	..	..	..	..	..	72	..	†	..	..	†	67
Cuba	..	..	..	..	..	18	..	..	..	..	..	23	..	..	..	..	..	23
Porto Rico, &c. ..	..	..	..	..	..	12	..	..	..	..	..	20	..	..	..	..	..	13
Brazil	..	..	..	..	..	36	..	..	..	..	..	59	..	..	..	..	..	44
Mauritius	..	..	..	..	..	6	..	..	..	..	..	33	..	..	..	..	..	33
British East India	..	..	..	..	..	14	..	..	..	..	..	18	..	..	..	..	..	15
Manilla & Java ..	..	..	..	..	..	40	..	..	..	..	..	37	..	..	..	..	..	28
Beetroot, &c.	..	..	..	..	..	6	..	..	..	..	..	47	..	..	..	..	..	63
Total, 1874 ..	100	70	10	52	232	174	131	92	42	85	350	309	110	75	38	86	309	286
Total, 1873 ..	73	56	6	39	58 increase		102	87	37	83	41 increase		96	61	36	93	23 increase	

* The particulars of stocks in different kinds of sugar cannot, at present, be given.

† Returns of the stocks and deliveries of the different kinds of sugar cannot now be obtained from Liverpool.

STATE AND PROSPECTS OF THE SUGAR MARKET.

During the earlier part of the month, the market remained very quiet, the speculative demand for lower kinds having subsided, and, to effect sales, rather easier prices were accepted.

Since then large arrivals have caused a further decline in prices, and the better kinds of refining sugars must be quoted 6d. to 9d. lower.

The stock of raw sugar in the United Kingdom—232,165 tons against 174,024 tons in 1873, and 94,638 tons in 1872—is more than sufficient to meet the increased consumption for the present, so that whilst the imports continue to be equal to the deliveries, we cannot anticipate any improvement in the prices of raw sugar.

The business in refined sugars was very active for some time, but towards the close of the month it was more difficult to sell, and in the finer kinds, and crystals especially, lower prices had to be taken.

The latest quotations report: No. 12 Havana afloat, 24s. 6d. to 25s. per cwt., or 6d. cheaper than last month; fair to good refining Cuba Muscovadoes, 21s. to 22s.; middling to good brown Bahia, 18s. 6d. to 19s. 6d. The price of common refined lump is 30s. to 31s., or about 9d. cheaper than last month.

The month closes with a quiet market for both raw and refined, with a tendency to lower prices, though, with sugar at its present value, we cannot anticipate any material change from present quotations.

THE
SUGAR CANE.

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☞ The writers alone are responsible for their statements.

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THE INTERNATIONAL SUGAR QUESTION.

We gave a prominent position in our last number to an article extracted from the French *Journal des Fabricants de Sucre*, on the present state of European legislation with regard to sugar. The time has come when the points touched on in that article must receive serious attention, not only from those European countries which still levy a duty on sugar, but also from British economists as well as the British sugar trade.

We return to the subject because it has become evident that the interests involved are wider than those originally connected with it, and that the prosperity of those who plant the sugar cane and import its produce are becoming seriously compromised, not by the legitimate success or the greater skill of their European competitors, but by the thoroughly vicious fiscal systems which have gradually become developed throughout Europe, and have now brought the trade of British sugar manufacturers and British sugar colonies to its present critical position.

The writer in the French journal has pointed out with great force that those interested in the present exaggerated production of beetroot sugar in Europe, exaggerated through the various systems of fiscal bounties, find it more and more difficult each year to secure a sufficient outlet for their produce. The English market is the principal object towards which all the beetroot sugar producers direct their operations, and the writer asks, very

pertinently, whether it will be wise for France to abolish her bounties on the export of refined sugar, when bounties on the export of raw sugar from Belgium, Holland, Austria, and Germany enable those countries to undersell French raw beetroot sugar in the British markets.

Those who advocate in France the immediate abolition of all bounties there, by extending to the refineries in that country the system of manufacturing in bond which has proved so successful in the beetroot factories and now so completely prevents any bounty being procured on the export of raw sugar from France, are not likely to lose sight of this point. It would no doubt be the worst possible policy for the French Government to continue this present loss to its treasury in the shape of bounties on the export of refined sugar, merely because other countries stimulate their trade into an unnatural growth by pursuing the same course. It is, however, by no means improbable that the French Government may take a different view.

The writer in the French journal asks whether, if England enters into a new convention, she will undertake to close her ports to all sugar which continues to enjoy a bounty on export. This is a difficult question. Those, no doubt, who are so glib in enunciating their views as to what does and what does not constitute free trade, would not hesitate to answer it with a very emphatic and slightly dogmatic negative. On the other hand, those who have carefully followed for the last few years the various phases of the international sugar question, will, we think, be disposed to look upon free trade as a rather more difficult and complex question than its ordinary votaries imagine. We do not know that there is any branch of trade which more fully illustrates this complexity than that of sugar. We are well aware that there are those who will maintain that all we have to do, in carrying out the principles of free trade, is to permit the British consumer to buy, without let or hindrance, in all the markets of the world. To those who have painfully experienced the present want of freedom in the sugar trade, this would appear to be more accurately described as "free consumption" than as "free trade." Such a system cannot even

claim to be called free importation. At this moment the British consumer is obliged, whether he like it or no, to import loaf sugar made from beetroot in France, because it receives a bounty on exportation, and therefore under-sells other loaf sugar. In the same way the British refiner is often compelled to buy his raw sugar from Austria, because it receives the greatest bounty on exportation, and therefore under-sells other raw sugar. For the same reason the importer from the colonies is often driven to sell his sugar at a lower price than he would otherwise obtain for it, owing to the bounties on exports from European countries. Again, the British refiner cannot obtain a fair price for his produce while sugar refined in Paris is sold in London at a lower price than it can be sold in Paris.

All these instances show that "free *trade*" is an incorrect term as applied to the system commonly known by that name, which, while it may enable the consumer to buy in the cheapest market, does not throw all markets open to him on equal terms, and certainly does not liberate trade from those tramels which result in unjust gain to the foreign and unjust loss to the home producer.

We know that any adverse criticisms directed towards the ordinarily received tenets of the free trade school are often repelled with accusations of protectionist tendencies on the part of the critic. This again arises from the imperfect and often incorrect meaning which attaches to the word protection. No one, in these days and in this country, advocates the artificial protection of an industry by the exclusion of foreign competition on equal terms. Neither does anyone in this country ask that bounties paid by foreign countries on the export of their produce should be met by British bounties on British produce. So far we would repudiate as strongly as our brother free traders any aspersion of protectionist tendencies. But we protest as strongly against any half measures with regard to free trade, and maintain that free trade to be effective must be universal. The half measures which have been applied to free trade were also resorted to, with equally unfortunate results, when slavery was abolished. At a great sacrifice of individual interests and at the cost of temporary ruin to our West Indian

colonies, we abolished slavery, but we took no effectual steps to secure its abolition by other counties. On the the contrary we put the finishing touch to our troubles in the West Indies by admitting slave grown sugar on equal terms with that produced by free labour. This was done in the name of free trade. It should rather have been called freedom to the foreign slave owner. The British planter and the British trader might be ruined that slavery should be abolished, but it was not permitted that the British consumer should pay any share towards the completion of so desirable an object. In the same way, having many years ago abolished all bounty on the export of sugar from this country, we now admit, from various quarters, sugar which receives a bonus sufficiently heavy seriously to affect the value of our home and colonial produce. This also is done in the name of free trade, but it would be more correctly described as freedom to foreign protection.

Within the last few days we have been told on high authority that, as the British Government have not succeeded, during the last nine years, in inducing France to observe the terms of the treaty of 1864, "it would not be consistent with the dignity of this country to press the point more than has been done." This means that if a commercial treaty is made and not kept, its terms cannot be enforced, and that there is no tribunal for the punishment of breach of international commercial contract.

That being so, would it not be well to make commercial treaties a little more on commercial principles? If there be countries, even of the first rank, who regard a commercial treaty merely as a means of obtaining as much advantage to themselves as possible, with the full intention of entirely disregarding all inconvenient engagements on their part, such countries appear eminently fitted for treatment similar to that which a person under like circumstances would receive in the world of commerce. In trade even the most punctilious have to deal occasionally with sharp practitioners, from whom they obtain fair dealing only by framing their contract in such a way as shall make strict adherence to it to the interest of those with whom they deal. The British Government, having no knowledge of such matters, has, in its commercial

arrangements with other countries, neglected to observe this elementary commercial rule, with the unfortunate result which the sugar trade, among others, now bitterly experiences. It is quite open to a Government to say, "No, we will not interfere with trade in any way," but if it takes the other course and undertakes to reform the principles of commerce and to substitute free trade for protection, it should, in dealing with commercial matters, have recourse to commercial principles of action. In this respect former governments, which have professed to be, *par excellence*, free trade governments, have, as the result has proved, greatly erred, and have, in the case of sugar, only succeeded in placing foreign protection on a firmer basis, by giving the protected trades a wider scope of action and a greater advantage over their "free" competitors.

It is to be hoped that in any future treaty a different policy will be pursued, and one more calculated, by being founded on a rational commercial basis, to ensure the observance of the terms of the contract. In making such a treaty, any man of ordinary business habits would stipulate, in establishing a system of free trade, that it should be equally adopted by all those countries who would benefit by the change. Any other principle than this may lead to free consumption, but will never give us free trade. "We care for no one but the consumer," say some *doctrinaire* enthusiasts. These are never commercial men. If they were they would know that the prosperity of the consumer, indeed his very existence, depends on the commerce of the country in which he lives, and that it is only if that commerce be truly free that he can flourish.

The word sugar offers an interesting subject for philological research. The Arabic word, and that of the Sanscrit, resemble closely those which, with slight variations, are found in different European languages. The language of Abyssinia, we are informed by Mr. Waldmeier, who spent ten years in that country (two of them n captivity, from which he was liberated by Lord Napier) expresses the idea of the sugar cane by the words *assat-mass*, literally *to draw not the juice*.—F.

THE EFFECT OF THE ABOLITION OF THE SUGAR DUTIES UPON THE VARIOUS SUGAR INTERESTS.

Ever since the time when the Emperor Charles the Fifth succeeded in defraying the cost of the magnificent palaces of Madrid and Toledo from the proceeds of the port duties levied upon the sugar imported from Hispaniola, the Governments of Europe have selected this substance to bear heavy customs imposts. This circumstance has not only unduly limited the consumption of the article, but from the difficulties inseparable from imposing the duties in such a manner as to tax each variety of sugar to its just extent, it has resulted that the whole trade has been maintained in an artificial state, and its current has been forced into channels along which it could not otherwise have flowed. But in certain instances justice among the various classes of sugar, or among those who produced them, was not even attempted, but, on the contrary, the "protection" of certain interests has been practised, with the necessary consequence of the repression of other interests and inevitable injury to the consumer, whose choice has been restricted, and to whom the price of the commodity has been increased.

Interference with trade not only inflicts certain real injuries upon some one or more interests, but it also produces divers imaginary injuries, and those, who have no real grievance to redress, indulge in the luxury of fictitious ones. The abolition of the sugar duties in the United Kingdom will permit the sugar trade to flow back into its natural channels, and for the first time during three hundred years it will be unfettered. Writers, who are little able to convince by the accuracy of their facts, and still less by the cogency of their logic, but who, like the heathen, nevertheless, think "they shall be heard by their much speaking," have insisted during a greater number of years than we care to estimate that the British system of classified sugar duties has offered an artificial stimulus to the manufacture of low sugars, to the profit of the British refiner, and has excluded from import, and thus discouraged the manufacture of certain fine sugars fitted for

immediate consumption that otherwise would have been made direct from the cane. Thus the want of financial success which has attended the operations of some of the magnificent vacuum pan factories, both in our Eastern empire and elsewhere, has been attributed to the alleged exclusion of their finer products from this country. It may be useful to endeavour to investigate this charge a little more closely, and to consider briefly the probable effect of free trade in sugar upon the various parties interested in it, and to ascertain whether any considerable change may be anticipated in the qualities of sugar imported, and in the varieties of sugar consumed in this kingdom.

It will be needful to glance at the changes in the means and sentiments of the masses of the sugar consumers of this country which have been in progress during the past twenty-five or thirty years. The increase in the material prosperity of this class has been unequalled during any similar period of history. This has shown itself, among other ways, by the demand for better houses and costlier clothing. Wooden clogs, printed calico dresses, fustian coats, and cotton corded trousers have been generally supplanted by shoes and by garments made from more expensive fabrics. The quantity and the quality of food consumed affords an index equally pointing to the change of circumstances. Oatmeal is now rarely used in England as human food, treacle has almost fallen out of consumption, the inferior qualities of tea are less in demand, whilst the finer sorts meet with an extraordinary sale, and, in fact, during the time under review, the consumption of tea per head of the population has doubled. The general prosperity is further evidenced by a like increase in the consumption of foreign wines. In view of these facts we should naturally expect to find a marked effect produced upon the article of sugar, particularly since, as in the case of wine and of tea, the purchasing power of the consumer has been extended by the lessened price, arising from a reduction in the customs' duties levied upon these articles of food or luxury. We therefore are quite prepared to find that the consumption of sugar per head has more than doubled. But what, for our present purpose, is much more noteworthy is,

that this evidence of prosperity is even more marked by the fastidious taste which has developed itself in the selection of the quality or appearance of the sugar which the consumer now demands. Most of the sugar sold a generation ago was a muscovado, and was denominated "brown or moist sugar," yet this variety is now but rarely used. As grey calico and brown holland have given place to bleached calico and white linen shirts, so the coloured sugar of the past has disappeared before the white sugar of the present, and the large sugar basin which adorns the free breakfast table of England is destined for the future to be filled alone with sugar purely white, and such being the case it may be well to consider by whom, in the great struggle for existence, this sugar basin can be replenished at the least cost.

If the taste for better sugar had developed in the direction of loaf sugar our task would have been a short one, for a tropical manufactory of fine loaf sugar does not exist, and no one has pretended to assert that such an undertaking could compete favourably with European refineries. It is, however, a singular circumstance that the consumption of loaf sugar in this country has scarcely extended, and this is the more remarkable as the consumer has been treated to it "at less than cost price" in consequence of the French Government having presented to its refiners a bounty on export to such an extent as to place "Say's loaves" in every town in England at a price at which (duty deducted) they could not be purchased to be consumed in Paris. Loaf sugar was once an exclusive luxury of the wealthier classes, and as such it seems destined to remain. The difficulty of breaking it and the impossibility of measuring out exact portions are among the chief reasons which account for its restricted use.

The sugar used in England is mainly of the white centrifugalled type. This may be produced in two ways:—1. By the British sugar refiner operating upon raw sugars of more or less rude manufacture; 2. Direct from the cane. The first method involves two independent processes of manufacture, one necessarily near the canefield, and the second usually near the place of import of the raw sugar. Two separate sets of packages are

required, two supplies of fuel are needed for the two separate concentrations, and two losses in weight upon manufacture are inevitable; and, lastly, two sets of manufacturers' profits are included in the selling price of the refined sugar.

The second method appears much more simple. The planter extends his necessary operations, and by the use of additional apparatus and more complicated processes he is enabled to obtain the greater part of his produce in the form of white, or nearly white, centrifugalled sugar; and thus he is enabled to dispense with the refiner, and would seem to be able to maintain a competition with the refiner which the latter could not sustain.

The subject is one of great interest, and upon it not the success alone, but the very existence of British sugar refining depends. Thus, those who have supposed that British sugar refining was sustained by a system of bounties afforded and cloaked by the system of classified duties, must have expected to see the prosperity of the industry decline in consequence of the successive reductions of duty, and to see it annihilated by their total repeal. Symptoms so alarming have not yet become apparent. No wail of anguish has been wrung from the refiners, and *The Sugar Cane*, which never disregards their interests, welcomes the emancipation of the trade as a real boon, and it would seem as if the future were indeed destined to be as the past, only much more abundant. If such really be the case, we must conclude that there are some advantages which the British refiner enjoys, or some obstacles in the path of the tropical white sugar makers that do not appear to the casual observer, and these we must endeavour to discover.

If white crystal sugar could be made in a simple manner, the British refiner would gladly modify his processes, but as this has not hitherto been possible, we find the plant of the refiner still remains one of the most costly and complicated used in the arts. He cannot make moderately white sugar, except with the use of a large quantity of animal charcoal, and he is unable to satisfy the demand of the consumer for perfectly white sugar without the use of enormous quantities of this filtering material. The demand for white sugar has grown so gradually and steadily that it is not

easy to remember what satisfied the purchaser twenty-five years ago. A brownish tint then passed for white. At one time, half a ton of animal charcoal was considered ample for a ton of sugar. An equal quantity is now an insufficient proportion, and frequently the first-mentioned position is reversed, half a ton of sugar receiving one ton of charcoal to purify it. This necessitates the use of colossal filtering cylinders, of many kilns, and much coal for the revivification of the charcoal, and for other purposes. The tropical refiner must either be content to make a sugar of less whiteness, or he must cumber himself with the costly charcoal plant on an extended scale. He must super-add to his cane-mill, clarifiers, and simple method of concentration, the costly and complicated plant of the refiner. To contest with the refiner, he must possess himself of the refiner's weapons, and his difficulty in wielding them efficiently lies in the following circumstances. With few exceptions, the cane harvest extends over four or five months only, and there is really no chance for the owner of the works in question during this short period to carry on a successful competition with the refiner, whose operations extend throughout the year. Half-time mills could not compete favourably with full-time mills. It is this circumstance, and the inconveniences which are inseparable from it, such as the difficulty of finding skilled workmen during one-third of the year, together with the necessity of importing much costly fuel from Europe, and carrying on the process of refining on a comparatively small scale, that constitute the main obstacles in the path of the tropical refiner.

The British refiner possesses certain advantages by which his position is improved. One of these lies in the circumstance that all moist sugars, not absolutely white in hue, lose in character and consequent value during the voyage home. Bloomy straw-coloured sugars leave the Mauritius or Demerara, and when opened in London they are found to have degenerated to a grey or brownish tint. Similar sugars leave the English refinery, but as they are sold in their bloomy state they realise a much higher price. If the British refinery suffer accident or derangement, a host of engineers is soon upon the spot, and the needful repairs are effected in the

least possible time and at the smallest cost. Coals are much less expensive than in the tropics, and the working expenses per ton of sugar are less heavy.

The British refiner finds the market, from which he selects his raw material, furnished with sugars from every place of supply; the crop from one colony is received at one time of the year, and that from another region at a different time. Beetroot sugar is imported from the Continent; raw sugar of low quality, the production of native makers, from countries where labour is cheap and the appliances are simple and inexpensive, is offered at a very moderate quotation, and the darkness of its colour and the injury it has sustained by the rude method of manufacture, are more than compensated by the lowness of its price.

Vicissitude of seasons affects the tropical refiner adversely. A year of drought may keep the costly plant in idleness almost throughout a season, but the great sugar-basin of England needs constant replenishing, and if a crop fail in one quarter its defect is made up by excess in some others, and refineries continue in constant operation.

Thus it would seem that there is little cause for alarm to the European refiner, and in most cases the covert difficulties of the tropical refiner will more than counterbalance the apparent advantages enjoyed by him. Even the tempting offer of the double profit disappears upon closer examination. Profit is reckoned upon the capital invested in a business. If, therefore, the refiner's profit is to disappear, it would still become an item of increased cost in the sugar, if the tropical maker required to invest as much capital in increased plant as the refiner would have employed to refine the same quantity of sugar per annum. It has been shown that the tropical refiner would only work during five months of the year, and would therefore require a much larger plant for each ton refined per annum than would suffice for the British refiner. Thus the amount of profit sufficient for the home refiner will not furnish an adequate return upon the capital of the tropical refiner.

Whilst the foregoing illustrates the general relation of the refiner and planter, there are special exceptions. All places of production

are not limited to a crop of five months, and all consumers are not so fastidious as the English. The long season of Demerara permits the manufacture of sugar to proceed during the greater part of the year, and costly vacuum pans are there profitably employed. The light-coloured sugars that are there made by means of the vacuum pan and centrifugal, with the use of bi-sulphide of lime as a bleaching agent, have found a ready sale in the United States, but the intelligent planters of that coast have had the good sense to avoid the use of the charcoal filter and the triple-effect vacuum pan. Thus it is probable that the methods adopted by the planters of Demerara will continue in favour in that colony, but that a greater proportion of its produce will find its way to the North American continent, and a less proportion will cross the Atlantic. The finer sugars of Cuba and of the Mauritius were not excluded by the classified duties; they did not reach England, and they will still not appear upon our market, for they will continue to find a better one elsewhere. The crystallised centrifugal sugars of the French Colonial Usines are too grey for our sugar basin, and needlessly good for our refiners, and they will therefore be sold elsewhere; and the produce of the central factories of the Viceroy of Egypt is practically unsaleable in England. Some of the finest specimens of tropical refining which have reached this country have come from the magnificent new central factory of the Colonial Company at Trinidad. This brilliant sugar, almost white, is suited to the English market. All that a costly and well-appointed factory wisely directed can effect has been done, and if any example of tropical refining in that island can become commercially successful it is this. It remains to be seen if the difficulties inseparable from tropical refining, previously adverted to, will not deter the enterprising proprietors of that factory from making a second.

For the future we may expect to find the English market supplied from almost every place of production with almost every variety of produce. Vacuum pans will still be exported to such colonies as Demerara. Concretors and vacuum pans combined will still be used in Peru and Australia to make a brilliant crystal. The increasing supply of concrete is doubtless destined to still

further augmentation, whilst the rude appliances of India and of Manilla are not likely to be soon changed, though, as knowledge and capital increase in these regions, the planters will cease to be contented with their present rude methods. White sugar almost alone will be consumed in this country, and unless some discovery is made by which white sugar can be obtained in a simple and inexpensive manner direct from the cane juice, the operations of the planter and refiner will be conducted apart, as are those of the cotton-ginner and the cotton-spinner. Sugar will be produced mainly where it can be produced most cheaply, and will be refined where it can be refined most cheaply.

The present period of depression, adverse alike to refiner and planter, will pass away, and the prosperity of all parties will be the more assured by their working for one another instead of against one another, and free trade in sugar will bring a blessing alike to the grower, to the refiner, and to the consumer.—*British Trade Journal.*

A VISIT TO THE FIRST CENTRAL SUGAR FACTORY ESTABLISHED IN PORTO RICO.

[Written for *the Sugar Cane.*]

On the north coast of Porto Rico, half way between the city of San Juan and the town of Arecibo, the first object which attracts attention on approaching the village of Vega Baja, is the factory of San Vicinti, the property of Don Leonardo Ygarravidez.

Generally speaking the north coast is level, the part, in proximity to the sea, swampy, or intersected with *canos*; behind this the level or slightly rolling land varies considerably in quality; the plains in the vicinity of the rivers and extending on either side some considerable distance into the interior are generally very fertile, that further distant, and into which, at places, project spurs of curiously formed hills or limestone rock, deeply verdant with vegetation, is of a sandy nature; and in some places distant from the rivers only sand is found, producing an inferior pasture;

this part of the country is however very picturesque, dotted with knolls and clusters of trees, and reminds one greatly of the park lands of Europe. A large extent of land is occupied by *estancieros*, who cultivate rice, tobacco, potatoes, beans, and sweet potatoes; and on the plains in the vicinity of the rivers are the sugar estates. In the vicinity of one of these rivers is situated Vega Baja, and the central factory is erected in the middle of the plain, having an abundant supply of water, used formerly to propel the water wheel of the cane mill; there is also a *cano* of some depth and navigable for lighters, extending up in close proximity to the factory.

San Vicinti consists of over 6000 acres, the greater part level and adapted for cane; in its immediate vicinity are several tolerably large estates, all more or less indebted to the energetic owner of the factory, and some of these estates will grind their canes at the factory mill, next crop, receiving 5 per cent. current price of sugar for them.

The old establishments were about the most commodious in the island, the curing house capable of containing 400 hogsheads is now partly allotted to the sugar coolers, and the remainder for apartments for the employés, the lower story serving as store rooms; the remainder of the building containing formerly four evaporators, "system Bour," two sets of coppers, a powerful engine and mill, water wheel and mill, still house, and at the further end a capacious dwelling house now converted into a blacksmith's shop, the machinery of which is to be worked by the water wheel; to this building has been added a three storied building of wood containing the clarifiers, subsiders, triple effect, vacuum pan, and centrifugals, capable of making 25 hogsheads a day; they were about erecting a powerful engine and mill in this part of the building, the former one being of the old American pattern, long and slender rollers travelling with too great speed to extract the juice properly from the cane. The present one has rollers of two metres long and ninety centimeters diameter, and will make two revolutions a minute.

All the machinery comes from the house of Cail. The machinery sent from this house is invariably of the best quality, but prices

are high, considerably more so than from the English or Belgian foundries, but I must in justice acknowledge that on my visit to the French islands, last year, it struck me the factories mounted under the direction of Cail's partners and with their machinery, appeared to work more smoothly than others I visited. The mills evidently did better work than those from several English houses I saw mounted in Martinique; that at Point Simon, in Port de France, did especial good work, the engine, 40 horse power, propelled the mill, the rollers of which were 1 metre 50 centimetres long by 80 centimetres diameter, making $2\frac{2}{10}$ revolutions a minute for 30 revolutions of the fly wheel, and the gudgeons working in the brasses 46 centimetres long by 32 centimetres diameter, this mill ground from 18 to 20,000 kilogrammes of cane per hour, which was wonderfully good work for such a mill; up to date there was in Porto Rico but one of Cail's mills, 16 horse power, rollers 4 feet 6 inches by 2 feet 2 inches; we have many more powerful engines and mills, but on the estate on which this mill is mounted, and of which I was for many years administrator, we used to make our twenty hogsheads a day; but my opinion is, cane mill rollers should have as much diameter as length, should travel but 10 or 12 feet per minute, having pinions and cheeks of proportionate strength, so as to crush a continual pour of cane, according to the strength of mill and requirement of work. This *plancha* of canes constantly fed in by the cane carrier should be from one to two feet in thickness, at this velocity and fed in this manner a mill will extract all the juice machinery can be made to extract; many powerful engines and large roller mills fail, owing to a want of regularity in the feeding, or from not having the gudgeons of the rollers, or the mill cheeks proportionately strong.

Over thirty years' experience as a practical planter, in all its grades, overseer, manager, attorney, and proprietor—may perhaps justify my having an opinion on the subject, although fully recognizing the impetus given to sugar manufacture by the establishment of the French factories, and acknowledging there is much to be acquired by visiting them, *I do not consider the result adequate to the outlay*; there are better and more economical modes of

making sugar, and I look on the triple effect as a cumbersome and expensive luxury: the results produced by it quite disappointed me; previous to visiting the French factories I had had long discussions with some of Cail's agents, and anticipated finding something better. All I can say in their favour is they look pretty.

I visited carefully the factory at Vega Baja, every thing is of the most solid construction, the hard wood posts, fixed solidly in the ground, are something worth looking at, they were from the forest-land of the Sugenio, and no weight of machinery is likely to shake them. They are some of the finest pieces of wood I have ever seen, and incline one to have more faith in the strength and durability of this part than in the solid mason-work of the older portion of the building; the machinery is well and conveniently mounted, the engineers had promised to have it in working order last February, but it was June before they could commence crops, consequently they could only grind the canes of the Sugenio. Fortunately the weather was favourable and they were able to take off the crop, but sugar must be made at its proper season, otherwise both present and ensuing crops suffer; being novices, and only grinding canes belonging to the property, there has been no account kept of the weight of cane, ground, or liquor concentrated, so no comparison could be drawn, but Don Leonardo Ygarravidez who now himself superintends everything, proposes keeping careful returns next crop.

The sugar I saw was of good quality, not such white crystals as those made in the French factories, and having a slightly unpleasant smell, owing to the want of filtration. It was very generally used in the city and towns on the north coast, and the Pulperos were retailing it at eight cents the pound.

Although some 1,500 hogsheads have been made, and the present machinery is capable of making in the usual crop time fully 3,000, it is far from being complete, attached to lands fully adequate to produce 5,000 hogsheads without encroaching on the forest or pasture lands, situated in the centre of a large plain, dotted with estates capable of producing as much more, with an easy means of forming tramways to the more interior village of Vega Alta and its cane producing lands, the success of the San Vicinti factory is only

a question of time more or less, according to the prices which may rule the sugar market. Don Leonardo Ygarravidez has been the first to break through, here, the old routine of sugar making, and he deserves to be successful; the organisation and division of labour made by him could scarcely be improved on, his tramways for supplying cane to the mill are judiciously distributed, and as far as I could see, in the two days spent at the Sugenio, everything worked smoothly. I had been invited to the inauguration; and several times, whilst they were making sugar; and regretted not having been able to see the machinery at work. It is difficult to form an opinion correctly of such an establishment as this, unless visited in crop time, there are so many small items requisite for the profitable and easy working of a sugar manufactory that can scarcely be suspected or a conclusion arrived at, unless sugar is in course of being made.

Many years since, I took the administration of what were then considered three of the finest sugar estates in Porto Rico, it was near crop time and everything was supposed to have been put in working order. On the larger estate where I took my residence, the building, 450 feet long, with water and steam mills, two sets of coppers and evaporators, looked to a planter's eye magnificent, but somehow the place had acquired the reputation of being unable ever to take off a crop. The day we proposed commencing I received a visit from an intimate friend and chief creditor, who was anxious to know if the crop could be taken off, we made a bet on the subject and I gained by a day. But my first reply was: "It looks pretty, I shall be able to judge better half-an-hour hence, when we get steam up." We did get it up and the water came out of the tubes of the multitubular boiler, the steam out of the dome and flanges, the cane carrier had a hitch in it, the evaporators would not work, and finally one Thursday morning, the two sets of newly mounted tayches caved in. We then pulled down the boilers, there were three, put back one, mounted our coppers, the two sets, and patched up everything. It did not look pretty but it worked, and in ten days we were making sugar again, and had no more trouble through crop. After crop I pulled everything down except the

mill and chimney, put it up according to my whims and fancies, and for two more crops never had a hitch, making twenty hogsheads of sugar every day we put the mill about. I merely cite this to prove my assertion, that it is very difficult to judge mills unless you see the machinery at work.

In all small communities, envy if not malice rules the order of things. Ours is not superior to others in this respect, and great and many were the predictions of failure made by Ygarravidez's neighbours, and as the factory is situated in close proximity to the high road from the city, it was a constant object of criticism by all travellers, and the constant *No sierve, No Predra siroir este*, was enough to discourage or at all events cause doubts to arise in the mind of any man, not thoroughly convinced by his own practical experience, that he was doing right; many anxious moments have no doubt been uselessly occasioned until finally the factory was set to work. A merchant and planter who goes to such an outlay confiding in the promises of the engineers, moreover Cail's engineers, who are supposed to be thoroughly practical men, and, destroying his old plant, trusts to their assurance that by February they will have everything ready again for sugar making, and sees pass by all the yielding months, which signifies less sugar for this crop and the next, and finds the end of June come upon him without a hogshead yet made, must have passed an anxious time of it. 100,000 dollars worth of produce a month later instead of sooner through a merchant's hands may cause a wonderful difference in his stability, or ability to meet compromises. A thriving prosperous man, who has become so from departing from his neighbours' accepted theory, is sure to be envied, and Ygarravidez richly deserves the success now again attending him, after so much trouble and anxiety as was uselessly forced on him.

The transfer of merchandise and produce to and from the city to the towns on the north coast is tedious and expensive, there are no good harbours, Arecibo is perhaps one of the most dangerous in the West Indies, the intermediate towns do all their country trade in lighters, San Vicinti ships its sugar on a crane pretty close to the works, but a concession has been made at Madrid by the Spanish

Government for the construction of a railroad all along the north coast, which if constructed, will pass close to the factory, and greatly facilitate operations. As all this coast is intersected by rivers and *canos*, an easy water communication might be made, but till lately the spirit of association has been wanted in Porto Rico, no great enterprises have ever been carried out. Government interference has checked it.

Returning to the city, a two hours' drive, principally through pastures belonging to Ygarravidez, brought us to the village of El Dorado. It had increased but little since I last saw it in 1855, it is in close proximity to a copious river, which flows down through an extensive plain pretty well covered with sugar cane plantations, and crossing the river in the ferry boat, we proceeded on through several fine estates and a long extent of uncultivated, but good land, to the Baymon river, near the outlet at Palo Seco; these two rivers are also connected by a *cano*, navigable, about half a mile only of this *cano* requires to be opened to render it possible for barges or small steamers to trade between the city and the villages in this neighbourhood, in the same manner as they do in Martinique, between Port de France and La Martin and Petit Bourg. The realisation of such an enterprise would bring prosperity to the various towns and villages in proximity to these rivers, and make them pleasant places of abode for persons whose occupations in the city only required their presence during the day.

No place in Porto Rico could be better adapted for a central sugar factory, than Palo Seco. Canes might be punted down from Buyamon, El Dorado and Toa Alta, and with tramways extending in all directions from these villages and stations all along these *canos*, thousands of acres of good land now uncultivated would soon be covered with cane.

The whole litoral of the bay of San Juan with the numerous *canos* extending eastward would change its aspect, as has been the case in the bay of St. de France, since the establishment of its various factories; a factory at Palo Seco would soon be supplied with canes sufficient to make 20 to 30,000 hogsheads sugar and bring prosperity to all the neighbourhood, besides augmenting the trade of San Juan.

If the proposed project of raising the loan of 7,000,000 dols., for compensation money, is carried into effect and dedicated as proposed to the establishment of central sugar factories, no doubt this will be one of the first spots selected, there are many excellent situations in the island for such establishments, but none present the same advantages as this.

From the ferry at Palo Seco to the village of Catano the drive is short; here we left the carriage and took boat to the city. Catano is now quite a prosperous village, having a church and many comfortable houses. When I first saw it in 1855, Catano boasted only three ranches; and old Pedro Josè who had peons and horses on hand to hire to travellers, was polite and civil to those only who brought him letters of recommendation from some person to whom it was his interest to be obliging. However, then, such as it was, there was a small steam-boat plying every half hour between it and the city.

Richard E. Burton.

THE MANUFACTURE AND REFINING OF SUGAR.

By Prosper M. Lagrange.

Translated and condensed by Waldron Shapleigh, F.C.S.

(Continued from p. 343.)

Part III.

Industrial Fabrication of Baryta.

I. *Attempts to employ baryta on a large scale; divers applications of baryta; works at Comines.*—After having described the theory of this new method, its industrial application, and the advantages which result, we shall proceed to give account of the manufacture of the baryta and basic-phosphate of ammonia.

Just at present the application of baryta has been very limited; consequently large establishments have not been created for its manufacture.

The use of baryta promised grand developments, when, at La Villette, M. Dubrunfaut, in 1850, treated the molasses of the

refineries of Paris by baryta, in order to extract the sugar in the form of sucrate of baryta, a reaction based on the interesting discovery made by M. Péligot, in 1839 : but a tax struck a death blow to this new industry and prevented this process from becoming general. But one establishment, that of M. Tilloy at Courrieres, continued the extraction of sugar from molasses by baryta ; but one manufactures exclusively this alkali for the needs of the works. The establishments of Limoges, M. Lelong at Grenelle, and others have made ineffectual efforts to fabricate the baryta on a large scale, with the hope of applying this alkali in the manufacture of glassware or the preparation of the binoxide of barium for the manufacture of oxygenated water, or for the extraction of oxygen from the atmosphere by the method of Boussingault, or better yet, as indicated by M. Margueritte and M. Sourdeval, for the production of the cyanurates and ammonia by condensation of the nitrogen of the air. In spite of this, the quantity of baryta employed for these uses does not offer, just at present, a market large enough for the manufacturers to advantageously increase the important material with any certain chance of its consumption. There exists but one establishment in France in which baryta is made on a large scale ; it is that at Comines, founded by Hentsch Lutscher & Co., and considerably enlarged by the Société Anonyme, which conducts this new process, to supply the increasing demands of the sugar industry. We shall now describe as completely as possible the different chemical reactions by the aid of which hydrate of baryta is prepared industrially.

II. *The mineral deposits ; choice of mineral ; its grinding and mixing with carbon.*—There exists two minerals of baryta suitable for the fabrication of this alkali—the carbonate or "witherite," and the sulphate or "heavy spar." Witherite is met with in France and Belgium, but above all in the north of England, the richest specimens coming from the mines of Alston Moor. A great heat is required to decompose this mineral ; as the preparation of baryta by calcination alone is practically impossible, it is mixed with 10 per cent. of carbon, the elimination of the carbonic acid being thus made more easy, though not complete ; with a temperature much higher, and which the furnace cannot resist, the yield is satisfactory. This

difficulty cannot at present be surmounted, in spite of the improvements made in the construction of reduction furnaces; and it is such, that, with the treatment of molasses by baryta for the extraction of sugar and the decomposition of the sucrate by carbonic acid, one can never revivify, in a complete and economical manner, all of the precipitated carbonate of baryta, although this salt in this state can be decomposed more easily than the "witherite;" one has then to renounce the employment of the carbonate of baryta for the manufacture of this base. Preference is given to the sulphate of baryta, which is much less expensive than witherite, and, moreover, it gives up more easily all of the baryta, in combination with the sulphuric acid. Heavy spar does not, like witherite, afford caustic baryta directly after the calcination, but requires different chemical transformations, very interesting, which are here described. The sulphate of baryta arrives at the works in lumps just as it is extracted from the mines. These are pulverised with a heavy Carr crusher. After grinding, an intimate mixture is made with 20 per cent. of coke or mineral coal. M. Nicklès has noticed that certain porous bodies assist the formation of carbonic oxide by heat; for instance, sawdust mixed with minerals being most favourable for its production, and giving the best yield. In spite of this observation, we give at present the preference to the coke and coal, of which the supply is more abundant and always to be relied upon. The mixture of carbon and mineral is immediately introduced into a gas-furnace analogous to the Siemens gas-furnace, to effect the deoxidation of the sulphate, and its transformation into sulphide of barium.

III. *The reduction furnace.*—The Siemens gas-furnace has proved itself best adapted for the reduction of sulphate of baryta, as it is so completely under the control of the workman, affording uniformity of temperature impossible to be maintained with an ordinary furnace. After each charge, which usually requires six hours, with constant stirring, the furnace is cleaned.

IV. *Lixiviating; desulphurization; crystallization.*—The operation of discharging is done as quickly as possible; the calcined product falls into a wagon which conveys the products to the lixiviating tanks containing water, and provided with mechanical

agitators and steam pipes. When the tanks are charged, the steam cocks are opened and the agitators put in motion. The operation is stopped when the liquors mark 25° B. They are then allowed to settle and the liquor rapidly decanted. The liquors are received in vats for desulphurizing together with the wash water of the residues, after being concentrated to 25° B. The sulphurous liquors are of a yellow color from the bisulphide of barium, and are, in a chemical point of view, very complex, being a mixture of a hydrate of baryta with $9H_2O$, protosulphide with $6H_2O$, of bisulphide of barium and sulphydrate of baryta. Whatever the state of sulphur in these liquids, it is easily separated by nearly all the metallic oxides. In order to operate the desulphurization, Kucrinski suggests the oxide of copper, but the revivification of the sulphide necessitates too great a loss. Litharge desulphurizes very rapidly in the cold, but from the high price of lead it is certain that this oxide will be equally rejected. The binoxide of manganese, proposed by Riegel, causes a desulphurization, but much slower than these last oxides ; if the binoxide of manganese be agitated in the cold with the decomposed sulphides and the temperature raised just to 50°, a chemical combination takes place. If, however, it is made to act on the warm solution, that is to say from 70° to 100°, the sulphur is oxidized by the oxygen given off, and in place of obtaining a solution of baryta, and a precipitated sulphide of manganese, the sulphide of barium is changed to sulphate, and not more than a trace of baryta is found in the solution. This is the drawback to the use of binoxide of manganese, of which the sulphide roasts so easily and the oxides are revivified completely at a low cost ; besides the action is too slow.

Many attempts have been made to employ the oxide of iron in both hot and cold solutions, and in the wet and dry way, but all have as yet proved futile.

Of all the oxides proposed, the oxide of zinc suggested by A. Muller is the only one which seems to have realized the economic conditions indispensable to working on a large scale. It is then to this oxide that we have recourse for the desulphurization of the sulphide of barium. It is introduced into the desulphurizing vats, heated by a steam coil, and furnished with mechanical agitators in

the proportion of 200 kilogrammes per 35 hectolitres of the liquid marking 25° B, brought to ebullition and agitated without ceasing. The operation is terminated when a drop of the liquor no longer blackens subacetate of lead. As the oxide of zinc is slightly soluble in alkaline liquids, the solution of baryta retains slight traces, but ou account of the insolubility of the oxide of zinc in the syrups, it is preferable that the baryta destined for the sugar industry contain a slight trace of this base than to have sulphide of barium. The desulphurization being complete, one obtains this insoluble sulphide of zinc and a liquid containing the hydrate of baryta. It is allowed to settle, and the baryta liquids, marking about 23° to 24° B., are withdrawn and sent directly to the crystallizing tanks. When the liquid cools, it does not mark more than 4° to 5° B. ; it is then decanted and concentrated to 24° B., and again crystallized. The crystals are turbined and the product thus obtained is BaO, H_2O, with 9 equivalents of water ; it is barrelled as rapidly as possible.

V. *Revivification of the sulphide of zinc.*—Sulphide of zinc, pure, is easily revivified and completely, by roasting or by chemical transformation. This is not the case with that which comes from the desulphurization of the sulphide of baryta, as it is always tainted with the baryta products, in spite of the frequent washings which it undergoes. The best method of revivifying sulphide of zinc is by roasting the washed sulphide of zinc. It is as thoroughly roasted as possible in furnaces analogous to those used in the roasting of pyrites. Sulphurous acid passes off, and the oxide is in condition to be again used in the manufacture of baryta. The different processes in use for the manufacture of this hydrate are all susceptible of improvement. Some endeavour to do away with the difficulty of the reduction of carbonate of baryta, formed by decomposing the sulphide of barium by carbonic acid ; others propose to obtain directly the baryta from the furnace after having mixed the sulphate with certain bodies capable of decomposing the sulphuric acid ; others try to put in practice the decomposition of chloride of barium by means of caustic soda.

The chloride is prepared by treating the carbonate or sulphide with common hydrochloric acid. The caustic soda decomposes the

chloride, forming caustic baryta and chloride of sodium ; the former crystallizes out of the solution.

Part IV.

Fabrication of the Basic Phosphate of Ammonia.

I. *History ; deposits of phosphate of lime ; phosphates, mineral and fossil ; richness ; physical and chemical distinctions ; choice of material ; works at Asnières.*—The manufacture of basic phosphate of ammonia is much less complex, and the necessary apparatus less expensive, than for the manufacture of baryta. Just at present, this salt, for which there are but few uses, has never been produced for the arts, and it is only made by the manufacturers of chemical substances for the use of the laboratories. The phosphate of ammonia has been used in the sugar works, but without success. It has also been used in agriculture, having in view the acid phosphate of ammonia $(NH_4)H_2PO_4.2H_2O$, but now the sulphate is the form in which the ammonia is introduced into agriculture. We can then affirm that the basic phosphate of ammonia has been, until the present, but a product of the laboratory, and not one of the arts. It was not introduced into practical use until 1871, and then in the refinery of M. Guillon, where I prepared it in quantity. The works of Asnières were established some time afterwards, and under the management of M. Storck, where it was made by the ton, crystallized and chemically pure. It was not until 1813 that M. Payen called the attention of the farmers to the efficacy of bone-black from factories and refineries as a fertilizer. M. Pierrie Figuier, the uncle of M. Louis Figuier, discovered the decolorizing properties of bone-black, properties which were shortly afterwards, and for the first time, put into use by the uncle of M. Adrien Guillon, the refiner. The English were the first to adopt it. In 1818 Berthier discovered at Wissant, in the Pas-de-Calais, the first deposit of mineral phosphate. In 1822 and 1829 Prof. Buckland announced that phosphate of lime was of animal origin, and was largely spread through the sedimentary formations, and the coprolites were the excrement and débris of divers animals, notably the large saurians, having found among them fragments of their bones and teeth.

The discovery of the mineral phosphate of lime called apatite, and of phosphorite, led naturally to a source of phosphoric acid. Con-

siderable deposits are found in Estramadura, Spain, and in France ; recently M. Daubrée has found large deposits in the Department of Lot and Lot-et-Garonne. The difference in the richness in these two minerals is that in the fossil phosphate, after analysis by M. Bobierre, is found a mean of 50 per cent. phosphate of lime, while in the other, by M. Janetas, 70 to 80 per cent. ; thus for the arts the apatites and phosphorites are preferred, and in agriculture the fossils, which are very easily assimilated, while the others require to be decomposed, forming super-phosphates by an energetic acid. It is easy, physically and chemically, to distinguish the fossil from the phosphate minerals. The coprolite nodules are in general of an oblong form, and of a darkish-brown, often of a greenish-grey, color. The animal substances have not entirely disappeared ; if they are boiled with a strong alkali, ammonia is disengaged.

In treating of the fabrication of baryta, the abundance of the deposits of minerals containing baryta has been indicated, leaving no doubts of the production of sufficient quantities of hydrate of baryta. The inexhaustible supply of phosphoric acid in the form of phosphates, and of ammonia from the gas works, from animal and vegetable sources, and possibly from the air, guarantee an unlimited supply of basic-phosphate of ammonia.

II. *Pulverization of the mineral ; the treatment by sulphuric acid ; exhausting the mass.*—For the fabrication of phosphoric acid, apatite and phosphorite are used in the form of a fine powder, and introduced through a hopper into a cylinder of cast-iron, having at one end a wooden conduit connected with the chimney to draw off all vapors and gases liberated during the action. The mineral is added in small portions, and an equal quantity of sulphuric acid of 66°, weight for weight. As the charge is added a cast-iron arm with paddles keeps the mass in constant agitation ; the mass becomes warm, and the action is allowed to continue for six hours. The pasty mass consists of a mixture of sulphate and acid phosphate of lime, and phosphoric and sulphuric acids. The lixiviator is a tank of wood, lined with lead, and divided into four compartments of equal size, furnished with steam pipes ; a quarter of the mass is placed in the first compartment, sufficient water is added to render the mass fluid, and brought to boiling ; wicker baskets, covered with coarse cloth, are

introduced to separate the acid liquid by filtration, the baskets serving as filters and as buckets to remove the fluid. This first liquor marks about 8° B., and is placed in the second compartment, a second quarter of the mass added, the liquid boiled and separated by the baskets and thrown into the third compartment, the third quarter added and the operation in this and in the fourth compartment conducted as before ; the second liquor marks 15° B., the third 20° B., and the fourth 25° B.

III. *Composition and purification of the acid waters at 25° B.; separation of sulphuric acid, sulphate and phosphate of lime; monobasic phosphate with two equivalents of water, precipitation in the form of crystalline bibasic phosphate with one equivalent of water.*—The composition of these waters is complex, consisting of a mixture of free phosphoric acid, acid phosphate of lime, and a small quantity of free sulphuric acid and sulphate of lime. They are collected in a wooden tank lined with lead, and the sulphuric acid and sulphate of lime separated by the acid phosphate or carbonate of baryta ; an analysis gives the quantity of sulphuric acid, and consequently the quantity of baryta necessary to be added. The precipitate always consists, in an acid solution, of sulphate of baryta ; the lime is left in the form of phosphate of lime, in solution in the phosphoric acid. A slight excess of the baryta salts is added so as always to have in the solution a trace of soluble phosphate of baryta in order to have no sulphuric acid. The solution is always tested to be sure of this. The acid liquid is separated by decantation. The strength is lowered by this treatment about 1° or 2° B. They yet contain phosphates of lime and baryta which separate on the neutralization by ammonia ; as the solution is made slightly alkaline, they are completely precipitated as phosphates, and separated by decantation or filtration. The liquid does not mark more than 20° B., and is composed of pure phosphoric acid combined with one equivalent of ammonia. If this salt is allowed to crystallize, it will have the formula $(NH_4)H_2PO_4.H_2O$. To obtain $(NH_4)_2H.PO_4.12H_2O$, it is necessary to have the monobasic solution as concentrated as possible ; without this the precipitation *en masse* of bibasic phosphate of ammonia would not take place.

The density of 20° B. is obtained without evaporation by following

the method of lixiviation mentioned, and is sufficient for a complete precipitation of the basic phosphate, which is conducted as follows: A solution of monophosphate of ammonia at 20° B., and one of ammonia at 22° B., are united in the proportion of 1½ equivalents of alkali to 1 equivalent of dry phosphate of ammonia. The solutions are introduced into the tank through two little glass jets placed side by side, the streams being controlled by pinch-cocks. As the two liquors mingle the bi-basic phosphate of ammonia falls in an almost dry crystalline mass. The operation is conducted in a closed vessel to prevent any loss of ammonia, and is also kept cold, as there is an elevation of temperature caused by the chemical combination. The crystalline mass is now submitted to the action of the hydraulic press and packed. The ammoniacal waters are distilled, the free ammonia being condensed to 22°. The pressed product consists of chemically pure crystallized phosphate of ammonia with the formula $(NH_4)_2HPO_4.12H_2O$.

IV. *Treatment of the residues.*—The residues from the mass after lixiviation are again treated with boiling water, which, after filtration, marks 50° B., and is again used for lixiviation, as also the water, from action of the filter presses. The cake is considered as waste, and consists of sulphate of lime with a very small quantity of phosphoric acid. The residues of sulphate of baryta are washed and used for the manufacture of baryta. Those of the phosphate of lime are, after washing, added to the powdered mineral phosphates. Thus the loss is but slight.

THE CONCRETOR IN TRINIDAD.

The Colonial Company were among the first to adopt the Concretor upon certain of their estates in Trinidad. Their estimate of the value of this invention, deduced from several years of actual experience, and in contrast with the various other methods of manufacture in operation upon their estates in this island and in neighbouring colonies, may be inferred from their having recently ordered three additional Concretors of the largest size to place upon the *El Socorro* estate.

THE LAGRANGE PROCESS.

The following translations of letters addressed to the Editor of the French *Journal des Fabricants de Sucre*, will interest such of our readers as have given their attention to the paper on M. Prosper Lagrange's Method of Refining Sugar, translated by Waldron Shapleigh, F.C.S., and concluded in our present number :—

Mr. Editor,

I have followed, with the greatest interest, all that has been published, and particularly what has appeared in your valuable journal, upon the Lagrange process. I have read and studied the *brochure* of this chemist, which is written with precision and perspicuity; and with an elegance well suited even to the most abstract theories.

My present object is only to place, before M. Lagrange, some objections to the use of baryta and phosphate of ammonia, which have often been made to myself by practical men.

I am happy to believe that M. Lagrange will not see any personal attack in what I am about to say. The desire of elucidating certain questions connected with his process, which appear to me very important, is my sole motive.

It is a certain fact, that every time we add a soluble phosphate to a syrup containing lime, or salts of lime, we set on foot a double decomposition. The lime is precipitated in the state of phosphate of lime, and the vegetable or mineral acid, combined with that lime, will form, with the base of the phosphate, another soluble salt.

When the acid, combined with the lime, is sulphuric acid, the baryta, having affinity for it, will eliminate it; but when the acid is of organic origin, what then will happen? Will it form, with the ammonia of the phosphate, an organic salt of ammonia? But how will this organic salt act upon sugar? If this salt remained in the syrup, it would only then be an exchange of base; the organic acid, instead of being combined with lime, would be combined with ammonia.

Would not the formation of this new salt be more dangerous

than the one which pre-existed? and would not the remedy be worse than the disease?

Let me hasten to say: It is true that the addition of baryta changes this combination, which is but provisionary.

When this base is found in presence of this ammoniacal salt, if the ammonia is only in the state of organic salt, M. Lagrange shows that this acid is precipitated by the baryta, and the ammonia set free.

Is M. Lagrange, however, quite sure that all the organic compounds are precipitated by the baryta, and that it does not form soluble compounds?

Here, already, is a point on which we should like to be satisfied.

But let us return to the organic salt of ammonia of which we have spoken. Soda and potash, says M. Lagrange, are found, in sugary products, associated with mineral and organic compounds: the baryta separates the acids, when in an insoluble state, and the bases are set at liberty. How then come these alkalis to act—potash and soda—upon the ammoniacal salt which has issued from the precipitation of the organic salts of lime, by the phosphate of ammonia? The ammonia will, clearly, be disengaged under their influence, but the acid—what will become of it?

Following the law of double decompositions, a soluble combination must be formed with the soda and potash. But, then, is it not to be feared that this new salt, which, from calcareous salt, becomes sodaic and potassic salt, may also, under this form, have an injurious action on the crystallisation of sugar, and that we may be exposed to turn in a vicious circle? What then happens to the organic salt of soda and potash?

Such is the second point which we will ask M. Lagrange to clear up, and of which we have had no explanation in his pamphlet.

We have also spoken of the possibility of the formation of an organic salt of soluble baryta. This hypothesis, which, in many circumstances, we should fear to see realized, would have this double danger—of retaining a salt perhaps more injurious than the first, and leaving, in the syrup, baryta in solution.

I have no need to call attention to the second danger. If

baryta, whose poisonous action is well known and indisputable, should be found in alimentary products, it is useless to enumerate the dangers which would result therefrom to the public health.

Baryta forms a soluble combination with vegetable acids, in syrups; and where glucose is present, how is it possible it should not also form a soluble combination? And in syrups of cane sugar, which always contain a good deal of glucose, would it not form a soluble salt?

We therefore ask, from M. Lagrange, categorical explanations upon this important question which concerns the public health.

Might not baryta, in solution in syrups, proceed also from another source? Might not the char contain baryta and give up this base to the syrups during their passage. Syrups do not always leave the Taylor filters bright. For one reason or other it may happen that they run muddy. We should like M. Lagrange to enlighten us equally on this subject.

We are far from contesting the results of the Lagrange process, which certain sugar refiners have been using for some time. There certainly ought to be admitted facts among them, and M. Lagrange could easily say to me: I have results which are satisfactory to myself.

I have, therefore, no wish to contest the value of this process, which two learned societies—the *Académie des Sciences*, and the *Société d'éncouragement*—have sanctioned. What I do desire, along with certain industries interested in the question, is, that these different theoretical and practical points of the process may be cleared up, and more precisely explained by the author.

Fernique, Chemical Engineer.

June 18th, 1874.

Mr. Editor,

You have published, in your last number, a letter relating to my process. The honourable engineer, who has been pleased to write to you, has made his attacks so courteously that I am very ready to answer the questions which he does me the honour to put, and which testify to an attentive and conscientious study of my method.

In this pacific contest, neither M. Fernique nor myself bring into it any other feeling than that of a desire for the promotion of truth and science; nor have we any other object than the interests of the sugar industry.

Without any doubt, experience having pronounced in favour of my process, now used in a great number of factories, I can reply to M. Fernique: "I *have* results which are satisfactory to myself." But what he desires are scientific explanations.

The honourable engineer asks me first if I am quite sure that *all the organic compounds*, existing in raw sugar, are precipitated by baryta.

No, they are not, and I have never pretended that they are. Will M. Fernique be pleased to take the trouble of reperusing the third paragraph of my pamphlet entitled, *The object of using baryta, and the basic phosphate of ammonia*, he will see that I express myself thus: "The new process of chemical purification, which I have the honour to communicate to the Academy, rests on the elimination of certain mineral and organic compounds, which are very injurious to the crystallisation of sugar, under the double action of baryta and phosphate of ammonia."

I purposely underline the words *certain compounds*, the better to show to M. Fernique that I have never practised any illusion on this point. But why have I not assured myself of the proportion of the organic substances eliminated, and those which were not, and which necessarily vary according to their nature, and their greater or less affinity for baryta?

It is by the use of sub-acetate of lead in the syrups, when the baryta has exhausted its action, that I have been able to arrive at a sufficiently accurate conclusion.

The organic precipitates of lead, collected, dried, and weighed, gave me the measure of the barytic purification, and the certainty that I had not eliminated all.

M. Fernique seems to be much disquieted on the subject of the organic salts of soda and potash. Whatever becomes of them? For what good purpose are a potassic and sodaic salt substituted for a calcareous salt? M. Fernique fears lest "I turn in a vicious circle."

The honourable engineer will permit me, in my turn, to ask him a very simple question.

If he finds himself sometimes, in the course of his industrial labours, in presence of *cuites* which the salts of lime had rendered heavy and motionless, or, at least, if they had not presented quite so heavy a character, has he made a close inspection of long and difficult *cuites*, in which no progress could be made, and of which the boilers were in despair?

There are, it is true, certain remedies for such accidents, such, for example, as an energetic passage over some good char; but, at such a moment, there is no time to have recourse to such a method. It is necessary, above all, to finish the *cuite*, and we can only further act upon the syrup by turbinage.

I do not know if M. Fernique, in such a case as I speak of, has seen, or has himself tried, the process of which M. Dubrunfaut has, for some time, recommended the use of, and which consists in introducing into the *cuite* apparatuses a solution of carbonate of soda or potash.

The most immoveable cuite immediately recommences its pace, and the boiler can form his grain as easily as if he had the best syrup in hand. This is a "fact of experience" which nobody can dispute.

What reaction is then produced, one may easily guess. The alkaline carbonate has yielded its carbonic acid to the lime, to form insoluble and inert carbonate of lime, and the soda and potash have united themselves with the vegetable and mineral acids combined with the lime.

In other terms, the calcareous salt which acted against the *cuite* is transformed into salt of soda and potass, and thus we have preserved the same equilibrium of salt in the syrup, its nature only being changed.

It would seem we have turned in a "vicious circle"; but, however vicious the circle may appear to be, we have not the less succeeded in changing a bad *cuite*, which produced an insufficient crystallisation, and a disastrous return, into a good one.

This is exactly what happens in my process. The substitution

of salt of soda or potash for calcareous salt has, therefore, nothing in it which should alarm M. Fernique; and though he may not be very desirous of repeating the experiment, which has become classic, he will have the certainty that baryta, in giving birth to these salts, far from injuring the sugar products, reduces, on the contrary, the rebellious *cuites* to order, produces vigorous crystallisation, and secures excellent returns.

M. Fernique afterwards asks me: What becomes of the salts of potash and soda? To be very precise, I am obliged to enter into some details, as well as theoretical and practical explanations, and connect the study of these compounds with that of the organic salts of ammonia, with which they have, as we shall see, some singular analogies.

We might easily mistake, for organic compounds of soda and potash, a remarkable, even curious phenomenon, of which, perhaps, M. Fernique has no suspicion.

Under the influence of ebullition, it would not be impossible that organic acids, in presence of alkalies, should undergo a kind of latent combustion, which might give birth to *carbonate* of soda or potash, whilst the equivalent of these, more simple and not so strong, ought not to exercise any bad effect on sugar, but, on the contrary, should confer a great advantage, on account of its alkaline properties.

Is not this, in fact, what takes place with certain organic products in presence of alkalies?

This hypothesis, entirely theoretic, which I have found it impossible directly to verify, in respect to the organic salts of potass and soda, I have been able to put in evidence, and experimentally assure myself of, in regard to the organic salt of ammonia.

When we treat syrups, containing organic salts of lime, with the basic phosphate of ammonia alone, without using baryta, we obtain a double decomposition, formed of insoluble phosphate of lime and an organic salt of soluble ammonia.

After filtration, if we submit, at the laboratory, such a syrup to the *cuite*, while taking care to collect and condense the vapours,

the condensed water contains carbonate of ammonia; and if we add to it a solution of baryta, we obtain an abundant precipitate of carbonate of baryta, the presence of which can be easily ascertained.

The organic salt of ammonia, which was immediately formed, is then changed by ebullition, and, in presence of an alkali, into carbonate of ammonia.

This experiment in the laboratory, made on a large scale, has given a result which, I believe, it will be interesting to make known.

When, after having treated in the refinery for several days certain sugar solutions with basic phosphate of ammonia, *without the addition of baryta*, the syrups arrived successively at the *cuite*, such considerable quantities of carbonate of ammonia were disengaged, that the condenser and pipes of the air pump were covered with a thick crust of carbonate of lime. At the end of three days, the vacuum pan was nearly choked up, the hollow spaces of the water pump were almost closed, and the valves of the air pump worked with difficulty.

It became necessary, after three days, to commence an energetic cleansing, when such operations are usually only performed every two months. The enormous quantity of carbonate of lime proceeded, evidently, from the reaction which took place between the carbonate of ammonia, carried along by the steam, and the sulphate of lime from the waters used for condensing, although the quantity of bicarbonate in those waters was excessively small. It was formed from the soluble sulphate of ammonia, and the carbonate of lime, which was deposited, and produced these incrustations, which, however, were extremely friable.

The phenomenon, which occurred with the organic salts of ammonia, is not of a nature to make me suppose that it can equally take place with the organic salts of potash and soda, and that these salts would really be transformed into alkaline carbonates. If I have entered into all these details, it is simply to demonstrate to M. Fernique that whatever form the salt of soda and potash may take, in substituting it for calcareous salt, I cannot be

logically blamed, either for injuring the crystallisation of sugar or the advancement of the industry.

I now arrive at the second objection of my honourable opponent, which is not less specious, while it may be regarded as more serious, because it touches on a point of the greatest importance—that of the public health.

M. Fernique believes that soluble compounds can be formed with baryta, and, as a consequence, that we are liable to leave traces of that base in the sugar.

I may answer, *a priori*, that certain organic compounds form, with baryta, quite as much soluble salt as lime, and that these compounds may be *glucosic* or *pectic* derivatives. I am, thus, in perfect agreement with M. Fernique on this point. It is undeniable that certain soluble combinations are formed with baryta. The essential point, however, is to state precisely if, in the method I have proposed, these combinations can take place, and in what conditions they can be maintained.

If M. Fernique will be pleased to refer to my pamphlet, he will find that, as to the quantities of baryta to be used, I have made a precise statement upon a very important point. I have said that it was necessary to add this base in such a manner as only to leave, in the syrups, a few per cents of matters still capable of being precipitated by it. I have also indicated a mode of estimation of which it is, besides, very easy to control the results with sulphuric acid—the reagent, *par excellence*, of baryta.

By observing these important conditions, I affirm that we ought never to have baryta in excess.

And how should it be otherwise? All beetroot syrups contain sulphates, having different origins, which we are careful completely to eliminate. Now how can it be supposed that a soluble compound of baryta can be formed in the presence of these salts? Would it not be destroyed as soon as formed?

In cane products, although they are often exempt from sulphates, and always contain glucose, we have no greater cause to fear the existence of the soluble salts of baryta.

Supposing that, in the cane, there may be, at times, vegetable

acids of different natures, capable of forming, with baryta—some of them soluble, others insoluble salts—soluble salts will never be formed if the method I have indicated be faithfully followed, which consists in only adding the baryta, as a previous analysis shall have determined, in such quantity as will form a precipitate, and only to leave in the syrup a few per cents of matter, still capable of precipitation.

A greater quantity of soluble salts will not be produced than if we had, for example, a liquid containing a mixture of chlorhydric and sulphuric acids.

Let us suppose that, for the purpose of transforming all the sulphuric acid into sulphate, three parts of baryta should be needed: if we only treat the liquid with one part of baryta, a precipitate of sulphate of baryta will be formed. But shall we, at the same time, obtain chloride of barium, which is soluble? If we filter the liquor, in order to separate the insoluble salt from it, we will not find any trace of baryta in the solution.

I cannot better apply this example than by this reaction of baryta upon the mineral or organic compounds of sugary products.

There is but one case in which baryta could be in excess in a syrup after filtration, and that would be where we had acted, by routine and at random, without noticing the least mixture. Happily empiric proceedings have had their time, and the heads of factories take too much care of their interests to trust their operations to unskilful hands, or to work without method.

Supposing, even, that by some improper management too much baryta had been added, should we not have, as an infallible remedy, the phosphate of ammonia, which would immediately precipitate the excess of baryta in the form of an insoluble phosphate?

Should we not also have, if this excess of reaction should elude scrutiny, animal charcoal, which absorbs barytic compounds as readily as calcareous salts, and which would come to our assistance as a corrective?

Animal charcoal, which, at this point of view can render certain services, serves precisely for a subject of criticism to M. Fernique.

The char, says he,—would they not contain baryta and yield that base to the syrups during their passage?

Syrups do not always run clear from the Taylor filters; for one cause or other they may run turbid.

The answer to this objection is very simple. When syrups run turbid from Taylor filters upon granulated charcoal, which sometimes happens, it is true, the precipitates scarcely penetrate 30 or 40 centimetres into the mass, and can only, in any case, have reached a very small fraction of the charcoal.

A simple washing with the Archimedean screw almost always suffices to detach, mechanically, the precipitate with which the char is impregnated. Supposing this washing to be insufficient, only a very small portion of the precipitates would remain in the char. Now, under what condition do they contain the baryta? In the state of sulphate and insoluble organic salt?

When we submit the char to calcination in the revivifying ovens, the organic salt of baryta is immediately transformed into insoluble and inert carbonate of baryta, and in order to decompose this carbonate into caustic baryta, a temperature would be required which our ovens can never reach, without the penalty of overburning the char.

As to the sulphate of baryta, it is necessary, in order to render it soluble, to transform it into sulphur of barium. Now, this reduction cannot be effected but at the expense of the carbon of the char, and at a temperature which is carefully avoided. This transformation is therefore little probable.

Let us suppose that a scorching heat burns the char, and reduces the sulphate to sulphide, should we not have, as a last recourse, the action of steam upon the char, an operation generally practised, in all works, after calcination?

Would not the sulphur be oxydised and transformed, anew, into inoffensive sulphate? Under this form, the poisonous action of the baryta, which M. Fernique dreads, with reason, would be completely neutralised.

However, it is not to-day that baryta has first attempted to find its way into the sugar house. Let M. Fernique go to Bercy to ask Dubrunfaut, who more than twenty years ago made so excellent an application of baryta at La Villette, if the sugars extracted

from molasses, by that base, contained soluble compounds of baryta, and have been attended with any inconveniences. And yet they employed this body in much larger proportions than in my method.

Let M. Fernique get admission, if he can, into the factory of M. Tilloy at Courrières. He will there, probably, be startled with the proportions of baryta, or sulphur of barium, used in the works.

Nevertheless, it does not appear that sugars, extracted by the aid of baryta, have ever done the least harm to consumers.

Such are the questions of M. Fernique, and such are my answers. Let M. Fernique, therefore, reassure himself. He can sweeten his coffee as safely with Guillon sugar, made with the help of baryta, as with Say sugar, clarified with bullocks' blood, after the old method.

I am, however, far from regretting this discussion. On the contrary, I thank M. Fernique for having furnished the occasion of more precisely describing certain reactions, of more clearly explaining their character, of dissipating certain fears or prejudices, from the public health point of view; and finally, of completing some theoretical explanations, which, far from having neglected, I had nearly ready for publication.

June 25th. (Signed) P. Lagrange.

FRENCH REFINED SUGAR IN ENGLAND.

From *La Sucrerie Indigéne.*

There has been much talk, and much discussion, in regard to the prices at which the French sugar refiners sell their refined sugars in England. It has been pretended that the disguised bounty on export has been the principal cause why the English have been able to buy them at lower rates than they could obtain similar goods from refiners of their own country. It has also been said that the French Treasury, whilst so largely involved in debt, has borne the loss incurred by this system.

Without quite agreeing in this view, we cannot aver that it is absolutely untrue. It is certain that, in the export trade, there are always some things which cannot easily be explained, and yet

1873.	Price of Parisian Refined Sugars, Free on Board, in England.				Price in Paris of Refined Sugar going into Home Consumption, exclusive of Duty (70.50), according to the Official List of the Paris Bourse.
	In Shillings and Pence per Quintal of 100lbs. 50k. 75.		In Francs per 100 Kilos.		
	Say.	Lebaudy.	Say.	Lebaudy.	
January	34/6 to 35/-	33/9	85 fr. to 86 fr.	83·00	87 fr. to 88 fr.
February	34/-	33/-	83·50	81·50	86 „ 87
March	34/-	33/-	83·50	81·50	87 „ 89
April	34/- to 34/3	33/-	83·50 to 84·25	81·50	87 „ 89
May	34/- „ 34/3	33/-	83·50 „ 84·25	81·50	.. 86
June	34/- „ 34/3	33/-	83·50 „ 84·25	81·50	85 „ 86
July	33/6 „ 34/3	32/6	82·50 „ 84·25	80·00	84 „ 85
August	33/- „ 33/6	31/6	81·50 „ 82·50	77·50	84 „ 85
September.....	32/6 „ 33/-	31/6	80·00 „ 81·25	77·50	84 „ 85
October		..		..	
November.....	32/6	30/9	80·00	75·75	83 „ 85
December.....		..		..	

(Signed) H. T.

which justify, if they are not explained, the recriminations of the sugar makers, who assert that the operations, of which they complain, have, for their sole object, the exclusion of the English refiners from our raw sugar markets.

However that may be, we annex a table, the particulars of which have been derived from the best sources, and which will throw a certain light on this much controverted question. If the figures which it contains are not disputed,—if they are absolutely true, as we believe them to be, the light will begin to dawn; let us even say that it is close upon us.

ACCOUNT OF AN EXPERIMENT WITH THE URBAN CANE MANURE IN ANTIGUA.

By Dr. T. L. Phipson, F.C.S., &c.,

Formerly of the University of Brussels.

I have just received (July, 1874) the report of a careful experimental trial of the Urban Cane Manure upon a rather ungrateful variety of soil in Antigua. Our readers know how difficult it is to obtain a perfectly conscientious report upon any manure, and how seldom we meet with persons capable of conducting such experiments, or willing to do so. I have not the pleasure of knowing Mr. Sutherland, the manager of North Sound estate, though his name is familiar to most of us, but he possesses, I am told, both the necessary ability to carry out an experiment of this sort and the courage to devote the proper time and care to it. Hence the value of his results. To myself they are exceedingly interesting, as I have often expressed my conviction that the Urban manure approaches nearer than any other to the wants of the West India cane soils, and I have already received ample proof from other quarters that, when properly used, it is tolerably certain to give satisfactory results.

The experiment in question was carried out, in the following manner, on No. 21 cane field on North Sound estate, Antigua, for

the crop of 1874, and I will give the results in Mr. Sutherland's own words. He says: —

"The soil selected for the experiment was a deep black loam of an uniform character, well prepared, double subsoiled, and deeply trenched at every 40 feet. To ensure accuracy, I took especial care to measure the area (2¼ acres) and to weigh the manure, which was applied at the rate of 5 cwts. to the acre when the canes were five months old. The distances observed in planting were 4 feet either way, the manure being deeply buried in the furrow equi-distant from each bunch. It was our last planted field, and not thoroughly established till March, 1873, yet in spite of the subsequent drought the canes grew with great vigour and regularity, and at maturity in the present month (May, 1874), though not very tall, they were stout and juicy, weighing per acre 86 tons 11 cwt. 2 qrs. 8lbs. These were carefully cut, ground, and boiled apart from the other canes, and yielded 4,185 gallons, marking 11½° Beaumé, which potted 3 (40 inch) hhds. and 2 barrels of sugar."

Considering the season, this result certainly appears satisfactory; but it is not the first time that reports have reached me showing that the Urban manure has been used with success in dry seasons, and even on very light soils. This has been notably the case in Barbadoes. Nevertheless, I think Mr. Sutherland would have obtained a much better result if he had not buried the manure quite so deep; three-quarters of a foot from the surface would, I believe, be the proper depth in most soils; and in some cases excellent results have been obtained by what is called "top-dressing" in this country, and also by irrigation, the manure being stirred up in the water used for this purpose. But the latter plan is rather troublesome. The reporter states that in the experiment just quoted the quantity of sugar obtained by the Urban manure exceeded that from the canes treated with Peruvian guano at 4 cwts. per acre on the same soil. "Had the season been more propitious, of course," he says, "better results would have been realized still. Even in an adverse year, and allowing for the advantages of deep tillage, the return from the Urban

manure has exceeded that from the Peruvian guano by nearly half a hogshead per acre."

I have only to add one remark to this, namely, that a very clever and conscientious experimenter in Jamaica, Mr. Bancroft Espent, informed me a little time ago, that on one of his estates the Urban manure produced a better result the second season than the first, no manure whatever being applied the second season. I can only suppose that this must be attributed to the general treatment of the soil, of which I have not the full particulars. It would be no less surprising than agreeable if such a result ensued also on these Antigua soils.

London, 10*th July*, 1874.

COLONIAL COMPANY, LIMITED.

The ordinary General Meeting of the Shareholders was held on Thursday, at the offices, Leadenhall-street; the Right Hon. E. P. Bouverie in the chair. The notice calling the meeting was read by Mr. E. Brown, the secretary; the directors' report was taken as read.

The Chairman, in moving the adoption of the report and accounts, expressed his regret that the results of the past year's operations had not been more favourable—in point of fact, the whole business of the year had been transacted without showing any profit or advantage to the company; really they might say that there was a trifling loss upon the year's operations, but, speaking roundly, the result of the year had been to show no profit. With regard to the *ad interim* dividend which the directors had been in the habit of making at this time of the year, it had necessarily been made upon an estimate by the managers of the probable state of business and the profits, and that was done last year; but the managers had over-estimated the probable amount of the profit, and the result had been that the company had divided a little more than it made. Referring to the report, he stated that it had been drawn up rather against the company than in favour of it, and it had not been coloured to make

it a less unattractive statement than it really was, but it was an accurate and truthful statement of last year's affairs. They had not taken credit in the profit and loss account for any interest in the large sum which was in suspense in establishing the great central factory in Trinidad, which he believed they would have been entitled to do; but they had, after due consideration, thought it wiser and more prudent to let the last year's profit bear the burden of that interest, and not credit it to profit and loss, and charge it against the usine. They had also, as they had done in previous years, debited to the year's revenue the extra outlay incurred in resisting the encroachments of the sea on two estates on the coast of Demerara. It might fairly be said that that was a capital expense. Last year £5000 was spent in those operations, but he hoped (as mentioned in the report) that they had almost seen the last of that expenditure, for the Government had at last found that the sea was not only encroaching upon this company's estates, but along the whole of that coast, and had prepared an elaborate plan, for the general protection of the coasts from the encroachments of the sea. He had reason to believe that that plan would be adopted, and would be carried out at the expense of the Government, the money no doubt to be raised by contributions from the proprietors who had the benefit of the protection thus afforded. As regarded the future of the company, its prospects were by no means gloomy. He had carefully looked into the matter, and he believed the real reason they had made no profit was that they had got a less value for their produce per acre than they had ever received since they had been in existence as a company, and in addition the cost of producing the sugar had been greater than it had ever been before. The imports had in no way fallen off —indeed they were as large, if not larger, than in any previous year. The value of the produce this year had been less, because the company had obtained a low price for the produce; the cost had been great per acre, because the yield had been small, and the expenses of cultivation in themselves had been great. The yield had been small, owing mainly to the seasons, over which the directors had no control; that the seasons had been unusually against them in the

last year there could be little doubt, and all who had experience in the West Indies agreed in saying that the continuance of the drought in the West Indies had been longer and more severe than was ever known in the industrial history of those islands. This had affected not only the yield of sugar, but had also increased the cost of cultivation; and the company had also had to contend, particularly in Demerara, with a disturbed state of the labour market, which was only now settling down. No doubt the Government inquiring into the condition of the coolie labourers in the colony, would eventually be productive of good and advantage to the labourers on the different estates, and therefore indirectly to the employers; but, in the first instance, it had been exceedingly costly to the employers and owners of plantations in the colony. As regarded the price obtained for the sugar, he had already mentioned that it was unusually low compared with the prices realised in past years; and this, in concomitance with the other causes he had mentioned, was really the solution of the problem as to how it came about that, with such large estates engaged in sugar production, they had not realised the return which might have been expected. Now, as regarded the future. Looking at all the circumstances of the case, he was inclined to believe that the price of sugar in future would never, except temporarily, reach a high price again, and a low price would probably rule in the sugar market; what they had to aim at, therefore, was to produce a larger quantity per acre, and diminish the cost of production—it was the only way, he believed, in which they could make sugar cultivation profitable for the future. It was also important to make sugar of the best quality; and the company had established a large factory in Trinidad, which was intended directly to have that effect, by turning the juice into sugar of the very best quality, instead of into brown, inferior Muscovado sugar. In this they had been most successful; and a short time since a sample from the central factory was analysed, and found to contain upwards of 99 per cent. of pure sugar. If they could do that at a reasonable cost, they had every chance—supposing the cultivation was good—that, in spite of the low price, they might get a considerable profit from the estates. At the same time it was

necessary that the cultivation should be carried on at as low a cost as was consistent with efficiency. That was what the directors were aiming at; their utmost efforts were constantly being directed to impressing upon those in charge of their estates in Demerara and Trinidad the necessity of the utmost economy, and he expected that, in ordinary years, fair returns would be obtained. Referring to the factory in Trinidad, he said that had been a very large and expensive operation; it was always contemplated as being an expensive work, but it proved rather more expensive than was contemplated, which was almost universally the case in all building operations. In addition, they had a great many difficulties to contend with of an unusual character; they had to get the machinery from France, at the time of the war between that country and Germany; a portion of the machinery had to be sent from England, just at the time there was a great disturbance in the labour market. Those were difficulties which could not be anticipated; but, although the usine had cost rather more than was originally contemplated, he saw no reason why it should not give a very good return. The cost for this great work had been met by issuing further debentures, rather than make a call upon the shareholders; and, with respect to the latter point, he might state, in answer to inquiries by one or two shareholders, that at present the directors had no intention whatever of making any call. Tho only other point on which he would touch, was that of an interim dividend; and the directors had thought, after the mistake which was undoubtedly made last year, that it would be more prudent not to make an interim dividend on the present occasion. Having again expressed his confidence in the success of the company, the Chairman concluded by moving the adoption of the report and accounts.

Mr. R. Gillespie seconded the resolution.

A short discussion ensued, in which Mr. Morris and Mr. Simpson took part, both of whom expressed their entire confidence in the able management of the company; and the latter gentleman suggested that, when the company was again earning large profits, instead of dividing so largely, or carrying so much to the reserve fund as they

had formerly done, it would be better to write up £5 on the shares, and so reduce the unpaid liability.

The Chairman said that the suggestion of Mr. Simpson was well worthy of consideration; and, having answered one or two minor questions relating to details of management, the resolutton for the adoption of the report and accounts was put and carried.

The retiring directors—Mr. R. Gillespie and Mr. W. Rennie—were re-elected, and a cordial vote of thanks having been passed to the chairman and directors, the meeting broke up.

THE SUGAR TRADE.

From "*The Colonial Standard and Jamaica Despatch.*"

Spring Garden, Buff Bay, P. O.
June 3, 1874.

Sir—I am very anxious to draw the attention of the Sugar Planters and all who are interested in Jamaica, to the results of the sugar convention of 1864 between England and the Continental Sugar countries, and to the causes that have led to the present depreciated value of our sugar.

It occurs to me that the best way of doing so is to address a Circular letter on the subject to the several Custodes and to send to the several newspapers a copy of this circular for publication. By this means it will be difficult for any one to miss seeing what I believe it is important for every one to see, and consider well.

In order to a proper consideration of the subject it is necessary that I should show the difference in the production of Beet Root Sugar before and since the Convention of 1864. In 1853, ten years before the Convention, the total production of Beet Root was 200,000 tons. In 1863, the year immediately preceding the Convention, the production was 349,000 tons. In 1873 the production was 1,143,000, and in 1874 the estimated production will be 1,150,000 tons.

The following table shows the production of each country in 1863 and in 1873, and the estimated produce in 1874:—

	Tons.		
	1863	1873	1874
Germany-Zollverein	142,000	409,000	320,000
France	99,000	259,000	400,000
Austria	57,000	214,000	175,000
Russia	32,000	150,000	150,000
Belgium, &c.	19,000	111,000	105,000
	349,000	1,143,000	1,150,000

It will be observed that whilst the production in 1853 was 149,000 tons less than 1863, that of 1873 is nearly 800,000 tons more than in 1863 and nearly a million tons more than in 1853.

I do not believe that the cause of this enormous increase of 800,000 tons in ten years is generally understood. Many account for it by the improvements that have been made in the beet-root and in its manufacture. I believe there is a deeper and more certain cause than either, and I will endeavour to explain it.

In 1864 the Continental sugar countries entrapped England into joining them in a sugar Convention to assimilate the duty on sugar and the mode of its assessment. From 1864 dates the rise of beetroot and the decay of Cane sugar. This Convention provided that the duties should be levied on the amount of pure crystallisable sugar or refined sugar present in each class of raw sugar; and it provided that the type for fixing what this amount of pure sugar was, should be that of the *color* of the raw sugar. In order to arrive at the value, in pure refined sugar, of the several classes of raw or colored sugar, a Refinery at Cologne was rented and experiments made therein. The results of these experiments were adopted and a set of "color" types agreed upon. Whether these experiments were conducted fairly or not signifies little, for no sooner was the duty fixed on a "color" type than the beet growers began to discolor their sugar. By means of caramel, analine brown, and other coloring substances, they were soon able to color the richest and purest sugar till it resembled the most impure. The art, if it can be so called, has been brought to such perfection, that a raw sugar possessing 90 per cent. of pure sugar is colored so that it should fall into the type that pays duty only on 70 per cent. A refiner buying this sugar, therefore gets 20 per cent. of his refined sugar free of all duty.

On the Continent the duties are very high, and they are collected in a peculiar way. A refiner, after buying raw sugar, gets three and in some cases four months' credit, without interest, for the duties, and if he exports in the time sufficient refined sugar to produce a refund equal to the amount debited to him for duty on the raw sugar, he never pays a penny in coin, he has only to hand in an export certificate representing a refund of duty equal to that of the duty to his debit. These export certificates are bought and sold on change, in like manner as all other securities.

Now suppose a refiner buys 1000 tons of raw sugar, containing 90 per per cent. of sugar, but discolored to appear as possessing only 70 per cent., he is debited with duty to the amount of£20,066 13 4
And the amount of duty to which he is entitled to a refund,
being that on the 90 per cent. he has obtained, is..... 25,800 0 0
He thus makes on this transaction, apart from trade profit, no less a sum than £5733 6s. 8d., which is equal to £5 7s. 8d. profit per ton.

Is it surprising then under such a system of protection, with a margin of £5 7s. 8d. per ton exclusive of trade profit, the continental refiner is enabled to sell sugar in London at a price that no British refiner operating on Colonial sugar can possibly compete with? Is it surprising that beet root flourishes and sugar cane decays?

If England desired the ruin of her sugar trade, as well home as colonial, she could not have devised a plan that will more surely accomplish it. But I do not believe in any intention of this kind. I believe England was duped by the continental nations, and I also believe that unless we petition Parliament to put an end to the protection enjoyed by beetroot growers and slaveholders we shall be speedily ruined.

We cannot ask that our produce should be protected, but we can fairly ask that England will not ruin us by compelling us to compete with protected sugar. If England will prohibit the importation into Great Britain of all sugar produced by means of the protection afforded by bounties on slave labour, she will compel all countries to produce sugar on the same conditions as she compels her Colonies to conform to. To do this will only be to apply at once those true principles of free trade that must in the long run place the production, as well as the importation of all sugars, on one equal footing. If not for the sake of her Colonies England can hardly refuse to accede to this, consistently with her advocacy of the doctrines of free trade.

In January last I sent to the late Honble. R. W. Smith a draft of a memorial to Parliament on this subject which he promised to lay before the Cornwall Club. I have recently been asked by one of our leading planters, at the suggestion of one of the largest West India Houses, to draft another memorial on the subject. I now enclose a copy of this draft, with a memorandum of the regulations required to be observed in regard to Petitions to Parliament, and I would urge you to bring the matter before the Planters of your parish with the least delay possible.

If all will merely consider the subject on its merits, a petition could easily be got ready for transmission by the Packet of the 9th of July—the latest that will ensure its consideration in the present Session.

There is no Association here, as in other countries, to take the initiative in such a matter as this; and I have delayed acting prominently in the matter in the hope and expectation that some one else would do so. But as time goes on and no one else moves, I am impelled to act. I can only hope for all our sakes that I shall not have acted in vain.

I am, Sir,

Your obedient Servant,

W. BANCROFT ESPEUT.

"WILL SUGAR-GROWING PAY IN THE SOUTHERN DISTRICTS?"

[See paper on this subject in our May number.]

I was sorry to see that Mr. Muir and "N.X.P." seem to have misunderstood the drift of my letter. The mistake seems to have arisen in this way—that whereas I apply the term "cane farmer" to a man with any number of acres of cane who farms or cultivates them properly, and "cane planter" to a man who plants any number of acres of cane, and lets them farm themselves, our friends who have written to you seem to understand the terms in quite a different way. With them cane farmer means a little man without a mill; and cane planter a big man with a mill.

Now I think that my term is the most applicable; and I apply it totally distinct from mill business. It is the term, in this district, that by the general run of people is the best understood. As I am a cane grower and manufacturer in the southern districts myself, I may be supposed not to wish to decry my own interests. I have found that *cane growers* have had their interests much damaged by the vagaries of *cane planters*, as I have found to my cost; and as no one had spoken, I thought I might be permitted to draw the attention of people to the fact that a wide distinction ought to be drawn between such men as Mr. Muir (whom I know and agree with in most things in reference to cane) and "cane planters." I certainly consider Mr. Muir one of the cane authorities in this district, and was suprised to see him take up the gloves for bad farming, under whatever name.

I don't think that either of your correspondents can maintain that sugar-boiling has not been, and is not even now, open to many improvements in our district; and if Mr. Muir, or any one as competent, will point out our mistakes, I for one shall be only too glad to correct mine, and feel greatly obliged for the information.

As to our progress compared with that of the Clarence, of New South Wales, and the northern districts of Queensland, I don't think half credit enough has been given to our district. The Clarence, I imagine, started sugar-growing with a large quantity of

land cleared and in cultivation. It was merely entering on another branch of farming with them, with a large bonus in the shape of duty in its favour; with a large population compared with ourselves to supply; with plenty of capital to be had to help them. The northern planters have, on the other hand, large tracts of naturally cleared land, and a full supply of capital. Now we have had heavy clearing, and very little assistance, until lately, from any other capital but our own, and our home market is more than supplied, so that we have little bonus in the shape of duty. Moreover, Queensland sugar-growers in general have been, and are being continually, hampered for want of sufficient labour, and by a short-sighted class in their endeavours to obtain coolies, or other labour suitable for the cultivation of tropical products, in which the sole employment of white labour is impossible, for the best of reasons—the breeches pocket.

Hoping this will correct any mistakes that may have arisen from my letter,—I remain, &c.,

P. X. N.

(From "Queenslander" of April 18, 1874.)

TWEED RIVER, QUEENSLAND.

April 18.

It is usual first to report upon the weather, and I cannot say anything in favour of it as regards the Tweed, for we have had it wet almost daily since December.

The two-year old cane, for the coming crushing season, is looking grand, in many instances ribbon and black canes show six to seven feet of crushing stalk, and being heavy at top from the continued moisture, are falling over; the ribbon more than the other.

One party, Messrs. Wells and Scammell, having constructed by their own clever ingenuity a three-roller horse mill, with battery and other utensils to match, about a month ago made a trial crushing, and under very unfavourable circumstances have produced a well grained sugar, of colour from a light grey up to a good yellow counter, dry and sweet. It is sold on the river at 4d. per lb. They have no centrifugal, and the only means of drying has been by dripping. The molasses thus made sold at two shillings a gallon. The density has so far fallen with the wet weather, that with other impediments

they did not find it profitable to go on till the proper season comes, and they rely upon the saccharometer showing up to 11° at that time. This is at any rate a start, and the Tweed folks are now consuming their own sugar. If even this little tangible fact had been shown two years ago, the Tweed lands could have been full of cane and be now sending away small cargoes to Sydney; for want of it the settlers knew not what to turn to in lieu of maize at 1s. a bushel, and the population has gone down from 450 to about 100. It should have been 1000 at least.

The Tweed Sugar Company have got their wharf erected for landing machinery, which is expected in due course. This work will show what the Tweed is capable of. Messrs. Wells and Scammell speak highly of the yield of the black cane, as well as the Diard green, to which they give the preference for yield and quality to the ribbon.

Arrowroot is showing a great crop, and a mill is being prepared to take it all at, I believe, £4 a ton for clean-dressed roots.

Mr. Brady speaks with great satisfaction of the manner the silk-worms from M. Roland's grain are turning out, and with these three new industries is connected the revival and success of the river, for maize growing has worn every one out.

Steps are being taken in Sydney to get our Bar looked to, and we believe it will be carried out with energy by the present Ministry, who seem to take a real interest in matters of local importance, when things are laid properly and in business shape before them.

It is reported that a Brisbane capitalist is about to put up a steam saw-mill here. There is plenty of cedar, beech, and hardwood to operate upon and keep the mill going for years to come. A steamer adapted to ply in and out to Brisbane and Sydney is another essential, and steps are being taken to obtain one by local ownership. We sincerely hope that these new matters may be carried out, and bring with them success and prosperity. Rations had run entirely out. We had no flour, no sugar or tea, no beef, slops, shoes or boots; waiting for a Sydney or Brisbane vessel to come to our relief, and we have now one from each port—things look a little more comfortable.

A little maize will go away to Brisbane, but the whole quantity on the river is hardly more or enough to feed the pigs required to keep the homesteads going. Its nominal value here is 3s. per bushel; quality very fine. *(From "Queenslander" of May* 18, 1874.)

THE SUGAR TRADE AND FRENCH DRAWBACKS ON EXPORTATION.

In reply to Mr. Forsyth, the Chancellor of the Exchequer said he had no objection to lay on the table the correspondence with the Committee of West India planters and merchants and Her Majesty's Government on the subject of the injuries inflicted on the sugar-producing colonies by the exportation of sugar under bounty from France and other continental countries. The hon. member for the Tower Hamlets had obtained certain returns, and he would suggest to his hon. friend to move for the correspondence as an addition to those returns. With respect to the second question, whether the Government, seeing the disastrous consequences likely to ensue to the sugar trade of the United Kingdom if steps are not aken to place sugar imported from the British colonies on an equal footing with that imported from the continent, will take measures as soon as possible to remedy this grievance, it was of a very important character, but not very easy to answer satisfactorily. The matter was under consideration as far back as 1864, when the Treaty of Commerce was concluded between France, Great Britain, Holland, and Belgium. It was then hoped that the provisions of that treaty would put a stop to the system of bounties which practically prevailed in France ; but although the treaty had been in operation for ten years, the effect of the stipulations inserted in the treaty had not been realised, and he was afraid that it would be of little use to continue to press the French Government for the more perfect execution of the treaty. The French Assembly had recently passed a law on refining in bond, and if that law was carried into effect it would in a great degree remedy the grievance complained of. He trusted that the French people would see that it was for the interest of the French taxpayers and producers that this system should be carried out, and the artificial system of bounties put an end to. He did not, however, think that it would be consistent with the dignity of this country to press the Government of France further with the views of Her Majesty's Government on this matter. The Government would always bear the question in mind, but he could not promise that the Government would take any special steps in the matter.

Stocks of Sugar in the Chief Markets of the World on the 1st June, for Three Years, in thousands of tons, to the nearest thousand.

	1874.	1873.	1872.
Great Britain	220	147	75
France	142	99	55
Holland	54	64	42
Germany (Zollverein)	16	11	9
Six other *entrepôts*	10	9	3
Total in Europe	442	330	184

Consumption of Sugar in Europe for Three Years, ending 1st June, in thousands of tons.

	1874.	1873.	1872.
Great Britain	821	714	686
France	252	248	273
Germany (Zollverein)	297	254	207
Holland	28	28	25
Six other *entrepôts*	111	102	104
Total in Europe	1,509	1,346	1,295

Estimated Crop of Beet Root Sugar on the Continent of Europe, for the ensuing Season, compared with that of the three previous Seasons.

(From Licht's Monthly Circular.)

	1873-74. Tons.	1872-73. Tons.	1871-72. Tons.	1870-71. Tons.
France	390,000	408,649	335,351	289,083
Germany (Zollvercin)	287,500	258,663	189,166	262,987
Austro-Hungary	170,000	214,106	161,526	182,280
Russia and Poland	150,000	150,000	90,000	135,000
Belgium	70,000	75,978	72,236	55,739
Holland and other Countries	37,500	35,000	25,000	17,500
Total	1,105,000	1,142,396	873,279	942,589

SUGAR STATISTICS—GREAT BRITAIN.

To July 18th, 1874 and 1873. In Thousands of Tons, to the Nearest Thousand.

	STOCKS.						IMPORTS.						DELIVERIES.					
	London.	Liverpool	Bristol.	Clyde.	Total, 1874.	Total, 1873.	London.	Liverpool	Bristol.	Clyde.	Total, 1874.	Total, 1873.	London.	Liverpool	Bristol.	Clyde.	Total, 1874.	Total, 1873.
*British West India	..	..	..	..	..	58	..	..	..	..	..	108	..	..	..	..	..	87
Cuba	..	..	..	..	..	22	..	..	..	..	..	43	..	..	..	..	..	39
Porto Rico, &c. ..	..	..	..	..	..	16	..	..	..	..	..	28	..	..	..	..	..	17
Brazil	..	..	..	..	..	41	..	..	..	..	..	70	..	..	..	..	..	50
Mauritius	..	..	..	..	..	4	..	..	..	..	..	35	..	..	..	..	..	37
British East India	..	..	..	..	..	16	..	..	..	..	..	20	..	..	..	..	..	16
Manilla & Java ..	..	..	..	..	..	39	..	..	..	..	..	40	..	..	..	..	..	32
Beetroot, &c.	..	..	..	..	..	4	..	..	..	..	..	50	..	..	..	..	..	67
Total, 1874 ..	106	69	10	55	240	200	161	106	49	104	420	394	135	89	45	102	371	345
Total, 1873 ..	80	63	6	51	40 increase		132	108	44	110	26 increase		119	75	43	108	26 increase	

* The particulars of stocks in different kinds of sugar cannot, at present, be given.

STATE AND PROSPECTS OF THE SUGAR MARKET.

The course of the sugar market during the past month has not presented any striking features. The early part being characterised by a dull tone, resulted after a fortnight in a fall of 6d. upon most of the refining kinds of raw, and rather more upon the corresponding qualities of refined. Owing, however, partly to a speculative demand, based upon the unusually small number of floating cargoes reported bound for the United Kingdom, the falling tendency of the market has been checked and the tone become much firmer, so that present quotations show little or no material change from those current at the close of June—in some cases, indeed, an improvement is apparent.

Reports from Cuba still bear evidence to the disorganisation and unsettlement experienced in all commercial transactions, consequent upon the extreme fluctuations in the rate of exchange.

In the statistical position it is to be noticed that the stock has begun its periodical descent; though the movement is not of great amount, yet it has this year commenced at a very early date, and already there is a perceptible decrease in the large surplus stock which has throughout the year been weighting the market.

The latest quotations of standard qualities of raw are as under: No. 12 Havana afloat, 24s. 6d. to 25s., being the same as last month; fair to good refining Cuba Muscovadoes, 21s. 6d. to 22s. 6d. or 6d. dearer; middling to good brown Bahia, 18s. to 19s., against 18s. 6d. to 19s. 6d. The price of common refined lump remains unchanged at 30s. to 31s. per cwt.

There still exists in the refined market, and consequently the effect is communicated also to the raw, a remarkable preference for the lower styles of sugar, a condition so opposed to that which prevailed throughout last year. The consequence of this is observable in the comparatively high prices which are obtained for Unclayed Manilla, Jaggery, and their corresponding refined productions, low pieces and yellow sugars, whilst the same feeling extends also to treacle which is now readily saleable at good prices. The reason of this state of things is not easy to assign, especially since all sorts of sugar are so cheap, but there can be no doubt that its effect must be to convince cane growers more and more of the expediency of sending in their produce in a simple and economical form.

THE
SUGAR CANE.

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☞ The writers alone are responsible for their statements.

For Table of Contents, see opposite the last page of each Number.

ON THE INFLUENCE OF FORESTS ON RAINFALL.

By Alfred Fryer.

(Concluded from p. 240, Vol. 5).

The Californian Horticulturist draws attention to the condition of San Diego, California. It states that previously to 1863 there was yearly a rainy season which made the soil nourishing and productive. In 1863 a destructive fire swept over the greater part of the country destroying the forest and blackening the hills. Since that time there has been no rainy season at San Diego.

Mr. Edmund Sturge has informed the writer that in Montserrat he has frequently noticed that showers which have descended copiously upon the forest, have not reached the open cleared land, and that on various occasions having been driven from the woods by the heavy rain, he has been surprised to find that on emerging from them, the shower had not extended beyond their borders. This confirms the experience of *Boussingault*, (p. 373, vol. 4.)

During some weeks' stay among the Pyrenees, Mr. Alliott and the writer carefully watched the formation of cloud upon the mountains, and in every instance observed that the cloud condensed from the transparent air over the wooded portions of the mountains, and in no instance did they observe the formation of cloud over the bare rocks.

In no colony has the destruction of wood been carried on in a more reckless manner than in the island of Antigua. The owners of old maps of that island find the word "spring" frequently

occurring, and in places where no vestige of a spring of water now remains.

The information that has been collected on this important subject, is so voluminous, that the lengthy extracts which have now extended through eleven articles in *The Sugar Cane* might readily be added to; but, it is thought that sufficient evidence has been adduced to shew that the most learned meteorologists and greatest travellers concur in connecting the existence of forest with water supply. Instead therefore of making further extracts, it may be convenient to summarise much of the matter already collected. It is grouped together as follows:—

Cutting Down Forests is Followed by Diminished Rainfall.

Boussingault. "My opinion is that the felling of forests * * has always the effect of lessening the mean annual fall of rain." (p. 374, Vol. 4.)

British Association Committee. "The indiscriminate clearing of forests around the localities whence the [water] supplies are derived is greatly to be deprecated." (p. 374, Vol. 4.)

Humboldt. South America. "The subsidence of Lake Tacaragua is attributed to clearing of forest." (p. 374, Vol. 4.)

Marsh. Atlantic States. "Places formerly abounding in water courses and rills having been cleared, in dry seasons now no longer afford herbage nor water. The fact is familiar." (p. 418, Vol. 4.)

Blanqui. Cape Verde Islands. "The terrible droughts which desolate them must be attributed to the destruction of the forests." (p. 419, Vol. 4.)

Strzelecki. New South Wales. "The destruction of forests has rendered the climate drier, and is threatening the interests of agriculture." (p. 420, Vol. 4.)

Meldrum. Mauritius. "The decrease of rainfall may in some measure be due to the cutting down of the forests. It was very well known that the climate became drier in proportion as the forests were cut down." (p. 422, Vol. 4.)

Graham. Madeira. "The woods were destroyed by fire to get land for culture of sugar cane, and the rainfall has diminished." (p. 423, Vol. 4.)

Gibson. India. "Cutting down trees has caused the climate to become drier." (p. 465, Vol. 4.)

Forest Inspector. India. "Cutting down the forests in Coorg has rendered both the earth and the air drier."

Australia. "In a particular district rainfall has diminished from 37 inches to 17 inches." (p. 466, Vol. 4.)

Sir R. Murchison. RUSSIA. "The axe of the miner has been a prime cause of this increasing drought. The inhabitants of the Ural mountains complaining of the annual decrease of water invariably refer this effect to the clearing away of the forest." (p. 529, Vol. 4.)

Professor Lindley. MAURITIUS. "If this island should in time become barren, it will only undergo the fate which universally attends the destruction or absence of forest in countries exposed to great solar heat." (p. 530, Vol. 4.)

Dalzell. NEW GRANADA. "The village of Ubate is now in the neighbourhood of two lakes, which 70 years before formed but one. The lake extending to the villa of Zimjaca has now receded to a league distant. The forest has been destroyed to furnish fuel to evaporate brine." (p. 531, Vol. 4.)

SPAIN. "The mountains of Estramadura and Murcia have been stripped of their forests, and there is now often no rain there for eight or ten months which forbids agriculture, while Catalonia and Valencia are covered with wood and possess a moist and productive soil." (p. 533, Vol. 4.)

AFRICA. "The fertile plains at the slopes of Mount Atlas have lost all their fertility with their streams and forests." (p. 533, Vol. 4.)

CANARY ISLANDS, THE MOUNTAINS OF GREECE AND MANY COUNTRIES, renowned in history for productiveness, despoiled of their forests are condemned to dearth, drought, and barrenness. (p. 533, Vol. 4.)

Moffat. AFRICA. "The Bechuanas are a nation of levellers, cutting down every species of timber, and they have the yearly custom of burning the dry grass, which on some occasions destroys shrubs and trees even to the very summit of the mountains. To this may be attributed the long succession of dry seasons. (p. 237, Vol. 5.)

"Since the destruction by fire of whole plains of wild olive trees near Grigua town, a gradual decrease of rain has succeeded." (p. 238, Vol. 5.)

Dean Stanley. PALESTINE. "The gradual cessation of rain produced by this loss of vegetation has exposed the country in a greater degree than in early times to the evils of drought." (p. 238, Vol. 5.)

THE EXISTENCE OF FORESTS PRODUCES RAIN.

Coultas. "The forests condense the vapour, * * and showers of rain are thus distilled * * by the woods." (p. 374, Vol. 4.)

Boussingault. SOUTH AMERICA. "The re-appearance of forest upon cleared lands was followed by a rising of the waters in the lake Tacaragua." (p. 375, Vol. 4.)

Blanqui. ST. HELENA. "The wooded surface has extended and the rain has increased in proportion. It is now double what it was during the residence of Napoleon." (p. 419, Vol. 4.)

Blanqui. EGYPT. "In this country recent plantations have caused rain." (p. 419, Vol. 4.)

Strzelecki. TASMANIA. "Less rain at Circular Head, clear of timber than at Woolnorth similarly situated, except that the latter is surrounded by forest." (p. 421, Vol. 4.)

Dean Stanley. PALESTINE. "The Kedron has recently flowed with a full torrent, evidently in consequence of the numerous enclosures of mulberry and olive groves, made within the last few years by the Greek convent." (p. 238, Vol. 5.)

Arrindell. UTAH. "When the Mormons first settled in Utah, they found the district barren. Water had to be brought almost incredible distances in wooden pipes. Trees were carefully planted and nourished with the water so brought, and now the district may be termed the garden of the world, and is not dependent on water brought from a distance but enjoys a steady rainfall." (p. 240, Vol. 5.)

THE DESTRUCTION OF FOREST IS FOLLOWED BY THE DRYING UP OF SPRINGS.

Strzelecki. "It is well established, that when forests are destroyed, springs of water become scanty." (p. 373, Vol. 4.)

Becquerel. "Great clearings diminish the quantity of spring water in a country." (p. 374, Vol. 4.)

Boussingault. ASCENSION. "The cutting down the wood from the sides of a mountain, was followed by the drying up of a spring at its base." (p. 419, Vol. 4.)

Marschaud. FRANCE. "After clearing the woods, the spring of Varieux lost more than half its water. The Wolf spring disappeared when the wood surrounding it was cut down." (p. 420, Vol. 4.)

Mathieu. FRANCE. "During seven months, the evaporation from cleared land was five times as much as from forest land." (p. 461, Vol. 4.)

Forest Commissioners. FRANCE. "Wood cuttings in elevated places cause diminution of springs, &c." (p. 464, Vol. 4.)

Gibson. BOMBAY. "Since the tract has been denuded of forest, the springs have left the upland." (p. 465, Vol. 4.)

Forest Inspector. INDIA. "A tropical forest is the *alma mater* of springs and streams." Various instances noted of springs and small streams that had become dry since the forests were cleared. (p. 465, Vol. 4.)

Commissioners' Report. MAURITIUS. "Unceasing streams were drying up in consequence of the diminishing area of forest land." (p. 466, Vol. 4.)

Dalzell, Conservator of Indian Forests. EUROPE. "The destruction of the forests has caused all the rivers of Europe to retreat to a lower level, and the drying up of innumerable springs." (p. 529, Vol. 4.)

Humboldt. "In felling the trees which cover the crowns and slopes of mountains, men in all climates seem to be bringing on future generations

two calamities at once, a want of fuel and a scarcity of water." (p. 530, Vol. 4.)

Under Secretary for India. "The most immediate cause of drought is or has been, the disappearance of wood." (p. 601, Vol. 4.)

De Saussure. SWITZERLAND. "The water of the lakes of Morat, Neuchatel, and of Bienne, has diminished since the clearing of the forests." (p. 139, Vol. 5.)

Choseul-Gouffier. ASIATIC TURKEY. "Was unable to retrace the river Scamander, navigable in the time of Pliny; its bed is now dry, bnt the cedars which covered Mount Ida where was its source, now no longer exist." (p. 139, Vol. 5.)

THE PLANTING OF TREES IS FOLLOWED BY THE FORMATION OF SPRINGS OF WATER.

Strzelecki. "Where forests have been encouraged to grow, springs are more abundant and their flow more regular." (p. 373, Vol. 4.)

Becquerel. "Forests besides preserving springs of water, regulate their flow." (p. 374, Vol. 4.)

Marsh. "A mountain spring which disappeared after clearing the ground—reappeared after planting—and has continued to flow uninterruptedly." (p. 419, Vol. 4.)

Boussingault. ASCENSION. "The replanting of a mountain caused a spring which had dried up after felling the wood, to flow again with its former abundance." (p. 419, Vol. 4.)

Marschaud. FRANCE. "The replanting of woods has been followed by the restoration of the spring of Varieux." (p. 420, Vol. 4.) "The Wolf spring of great celebrity, came into existence after the land about it was planted." (p. 420, Vol. 4.)

Graham. MADEIRA. "Formerly presented a vegetation truly astonishing, and innumerable springs." (p. 422, Vol. 4.)

Boussingault. BOLIVIA. "While the levels of various lakes, the forests in the neighbourhood of which had been cleared, had subsided, other lakes such as that of Tota, situated in localities where there had been no forest clearing, had not shewn any falling off in their waters." (p. 139, Vol. 5.)

PLACES THAT HAVE FORMERLY POSSESSED AN ARBOREAL VEGETATION THAT HAVE BECOME MORE OR LESS DESERT FROM THE CHANGE OF CLIMATE, PROBABLY CAUSED BY THE DESTRUCTION OF THE TREES.

Dalzell Conservator of Indian Forests. ALGERIA. "In plains of Mitidjah and province of Oran there are traces of an extinct vegetation where all is

now sterile. In the province of Constantine, where formerly a dense vegetation existed, a tree does not now exist. Judea had ancient forests, now sought for in vain. Lebanon, Antilebanon, and Bashan were formerly famous for forests of timber and now scarcely any remains. Cyprus formerly densely wooded, is now bare and dry." (p. 530, Vol. 4.)

Author of Desert of the Exodus. Arabia. "The region was once a well wooded one, whereas a single tree is now a notable object. The trees have been cut down to smelt copper. Huge heaps of slag remain. Nothing in physical geography is better established than that the destruction of forests deminishes the amount of rainfall, and that fertility depends essentially upon this. 'To cut down the trees' was among the Greeks the phrase to designate the permanent devastation of a region. (p. 239, vol. 5.)

Africa. "It is the destruction of forests more than any one thing, which has within a few centuries transformed the African shores of the Mediterranean, once a granary of the Roman empire, into a desert." (p. 239, vol. 5.)

Californian Horticulturalist. California. "The greater part of San Diego was devastated by fire in 1863, and since that time the annual rainy season has ceased."

What reliance is to be placed on all the foregoing evidence? The area it covers is almost co-extensive with the world itself, embracing Europe, Asia, Africa, America, Australia, and various outlying islands. The period of time it embraces is co-extensive with human history. A portion of the evidence relates to effects produced within a single life-time, another portion to those which have required one or two centuries for their development. Certain effects have been traced to causes in operation since the dark ages, whilst others extend to the period during which the Roman empire flourished. Some evidence is derived from the time of the still earlier Greek civilization, and further from the very dawn of history in Palestine. The list of compilers of the evidence and the witnesses include some of the foremost men of science and travel that have adorned the present century; and also of experts who have made the investigation of this subject their special study. So convincing has this evidence proved that Governments on every side have become alive to the question; and departments have been organized, and large sums of money have been spent in order to preserve the trees.

Means Adopted in various Countries to Preserve the Forests.

French Government—appointed commissioners to investigate the cause of the diminution of springs, &c., and in 1859 an ordinance was passed to restrict the cuting down of immature trees, and another ordinance was passed in 1860 to encourage proprietors to plant land." (p. 464, vol. 4).

Italian Government—adopted similar measures to those of France. Encourages sale of forest land to Government." (p. 465, vol. 4.)

Indian Government—appointed commissioners and has taken measures for forest conservancy." (p. 464, vol. 4.)

Mauritius Government—appointed a commission, &c." (p. 466, vol. 4.)

Massachussetts State Agricultural Society—voted 10,000 dollars to the proprietor who has planted most land. (p. 466, vol. 4.)

Australian Governments.—One of these has organized a department for preservation and extension of forests. (p. 466, vol. 4.)

German and French Governments—require those who maintain the district roads to plant trees along them. (p. 468, vol. 4.)

Austrian Government—protects the forests, which are called the sources of the nation's wealth. (p. 534, vol. 4.)

China.—Groves are maintained along the courses of the rivers and canals. (p. 239, vol. 5.) In certain provinces the destruction of trees is illegal. (p. 240, vol. 5.)

Japan.—The cutting down of a tree without planting another is a crime punishable with death. (p. 240, vol. 5.)

Hong Kong.—Injury to or destruction of trees is severely punished. (p. 240, vol. 5.)

United States.—Certain local governments grant a bonus for the establishing a certain number of trees.

What is to be said *per contra*. Where are the accumulations of fact to be placed in array for the purpose of establishing that the water supply of a country or of an island is NOT affected by the presence or absence of forest? Where are the opinions of *savants* and travellers to this purport placed on record? Where is the Government that has retraced its steps and permitted the destruction of forest because its preservation has been found to be unimportant? It is to be feared that such evidence is not forthcoming, and that the statements we have been examining are substantially correct.

It seems to be generally believed that trees produce the following effects:—

(*a*).—They increase the amount of rainfall. This they probably effect thus.—(1.) They lower the temperature, and thus cause the moisture-laden air first to become visible as cloud, and second to be precipitated as rain. (2.) They intercept, and, as it were, tap the vapour-charged winds. (3.) They supersede the state of tension and polarisation which exists when an electrified cloud is above them, by silently discharging the electricity. The discharge of electricity, as for example in the case of thunder storms, is generally accompanied by rain.

(*b*)—The foliage and branches of trees oppose the momentum of the rain drops, and suffer the water to fall more gently to the earth, checking the tendency to wash it away.

(*c*)—The roots of trees bind the soil together, offering an obstacle to its being washed away by rain.

(*d*)—The decaying leaves form a sponge which absorbs the water and permits it to drain away but slowly.

(*e*)—The shelter afforded by trees prevents rapid evaporation from the ground or from water courses or ponds beneath them.

It is well known that a moderate amount of rain falls upon the ocean far away from land, and it may be thought by some that the absence of trees cannot reduce the rainfall to an amount less than the fall at sea, which may be considered the normal fall. That from some cause or other a less amount of rain may fall upon land than sea is evident from the existence of the rainless districts of North Africa, of Thibet, of Mexico, and of Peru.

In order to attract rain it has been shown that the surface must be covered with objects (like trees) which produce a diminution of temperature; which can intercept the currents of air, and which are good conductors of electricity. It is evident that as the currents of air move more rapidly in proportion to their altitude, that the more elevated the objects the more powerful will be the influence exerted by them for better or for worse. The whole amount of moisture raised into the atmosphere from the surface of the ocean, and of moist earth, vegetation, and fresh water, must of necessity be precipitated again, and that which is not discharged upon the land is poured upon the water. The land from the character of its surface and the nature of its covering as well as from the degree of its elevation presents a selective

influence which determines within certain limits, the amount of water that will be precipitated upon its surface.

Let us imagine three different islands in the same tropical latitude, distant from each other, and from other land. One island shall be covered with wooded mountains; the second with bare mountain, and the third covered with grass. The first island will receive the normal amount of rainfall, that is the amount that would fall upon an equal area of ocean, and besides this it will receive a second supply that will have been induced by the influence of the trees, this influence being increased by their elevation above the sea level. The bare rock of the second island will receive abundant heat by the sun's rays, and being unable to convert it into latent heat by the evaporation of moisture from vegetation it will discharge it in the form of radiant heat both by day and night. It has been shown however that the fall of rain often depends upon the clothing of the ground being cooler than the air; but where heated rock is presented the temperature will be actually raised, and an active repellent action will be set up in consequence. Dry rock is a bad conductor of electricity and therefore cannot induce rain by restoring the equilibrium when it is disturbed by the presence of a thunder cloud. Neither does it offer the multitude of points presented by foliage. Thus none of the rain that trees would have attracted will be received, and even a considerable portion of the normal rain will be repelled. That part of the normal portion which is not influenced by the contact of the surcharged air with the surface of the ground, but which is precipitated from the tropical regions, will still fall upon the island, and this is the most violent portion of the rainfall. The third island will also receive this violent portion of the rainfall which is not dependant upon the character of the surface. In addition to this when the grass is green it will attract rain in the same manner as trees, but to a less extent, because the evaporating surface is smaller and the vegetable electrical conductors are fewer and less elevated. But when the grass becomes dry and withered its action will become repellent, and instead of producing cool air by evaporation it will produce hot air by radiation, also dry grass being a non-conductor it is powerless to produce precipitation by restoring the electrical equilibrium.

The luxuriance of vegetation does not depend upon the amount of rainfall, but upon a sufficiency of moisture finding its way to the roots of the plants. A heavy tropical rain of, say five inches in a single day, produces no more good than a gentle, continuous rain of one inch during the same period, as four-fifths of the former rain is carried away by streams into the sea, and some valuable soil with it. Gentle rain is all utilized; every drop soaks into the ground; neither water nor soil is carried away.

If the foregoing explanations are correct it will follow that the gentle showers are attracted by the trees, and that the violent rain will fall whether trees are present or not. But the trees on the slopes of the mountains check the fury of the violent rains, prevent the low lands from being flooded, and save the soil from being washed away.

The object of the writer of these papers has been to second the efforts of Governor Rawson, of Bishop Westerby, and others who have from time to time raised a warning voice to the more intelligent portion of the inhabitants of the British West Indies. This subject is worthy the consideration of the governing bodies of all the islands, for even such fortunately circumstanced communities as the inhabitants of Trinidad, Dominica, and Montserrat cannot be too sensible of the importance of protecting their woods, whilst others less happily circumstanced should understand the necessity for doing penance for past sins, or they may expect no escape from the consequences.

To the inhabitants of Antigua the subject is of as deep importance as to any, and as its condition is better known to the writer than that of most other islands, the remaining portion of this article may suitably be devoted to the consideration of the subject as affecting that island.

Ever since its first colonization Antigua has possessed the unenviable notoriety of being a dry island, and has at intervals sustained severe droughts, which have caused failure of the crops, and much suffering to the inhabitants. As the flat land lies to the North and East of the island and the mountainous district to the South and West, the prevailing winds pass over the greater portion of the cultivation before they reach the sides of the mountains.

Hence to some extent their rain-producing power is lost. But even if no mountains existed to the South and West the remainder of the island should receive at any rate a normal amount of rain. The average rainfall upon the island is however perhaps only *one half* of that of the adjacent and visible islands of Guadaloupe, Montserrat, and St. Christophers. This small rainfall can only be attributed to local influences, indeed Antigua is better placed for taking the first charge of moisture from the laden air, as it lies to windward of the other islands. Many indications exist to show that the climate is more dry than formerly, and that the destruction of forest has proceeded at an accelerated rate. The drying up of the springs has already been noted. The absence of a regular rainy season, such as in past times was general, is a circumstance of common notoriety. The water accumulated in Body Ponds is less than formerly. The large silk-cotton trees found here and there attest that trees could formerly attain maturity. Few or no trees of similar kind are growing to take their place. The roots of large trees are found where no trees grow at present. The hills formerly covered with wood are now divested of it, and their bare and dreary appearance as the island is approached offers a marked contrast to the luxuriant growth of wood, which covers the sides of the beautiful islands of Guadaloupe and Montserrat. The frequency, and the long continuance of recent droughts has exceeded those previously recorded; in fact the maintenance of the island at all as a sugar-producing colony, is mainly due to the introduction of the cattle plough, and more recently of the steam plough, the deeper cultivation permitting a considerable portion of the little rain that falls, to be absorbed by the land.

It has been shown that in temperate climates, such as Russia, France, and the United States, where the solar heat is moderate in fervour, and where long winters ensure a humid soil for many months during each year, where the crops are varied and the occupation of the inhabitants is not confined to agriculture, the conservation of forests is deemed of vital importance, and the efforts of the Governments are directed to their protection and extension.

In what respects does Antigua differ from these countries? It is situated within the tropics. The sun is in the zenith twice each

year, and it is at no period far from vertical at noon. It is entirely devoted to the cultivation of a plant that is in fact a reed, and that is more dependant on the presence of abundant moisture than any plant important to man, rice alone excepted. Its conformation is such that at best the supply of water may be expected to be scanty, and its history shews that frequent drought has been its lot. There is perhaps no place on the earth's surface where the art of encouraging the rainfall is more needful, than in the island of Antigua.

Would it be a libel to assert that the Negroes, the Planters and the Governing bodies have vied with each other in the production of drought, and in hastening the ruin of the people and abandonment of the colony? The following statements may help to decide.

The Negroes. It might be supposed that the black population of this island were a portion of the nation of Bechuanas, described by Moffat, for the account of them applies equally to the negroes of Antigua. The practice of "burning off the bush" seems to be universal. Night after night, fires are seen creeping up the hill sides, in some places a line of light, and in others a terrible fire rushing rapidly along. These fires often extend far beyond the limits designed, and not unfrequently to considerable distances, and many a blackened patch of burnt canes marks the immediate penalty that the negro has to pay for this barbarous practice. If the ingenuity of man had been taxed to find out the readiest means of destroying the vegetation and ruining the climate, it would have failed to surpass that of placing a fire-brand in the hands of the negro on the parched island of Antigua. Almost every tree in its turn would be swathed in its sheet of flame, but the negro, more zealous apparently for the ruin of the climate than for any other work, and not content to allow the trees to stand until the prairie fire reaches them—has taken care to ignite a fire at the root of almost every large tree he has access to, so that often a blackened recess corrodes the base of the few trees left standing. Thus the little wood becomes still less, and even this must be laid under contribution to furnish the fuel needed for the negro, and for the various purposes for which he needs a piece of wood. Let us remember, however, that the negro is poor, is ignorant, and has little to do

with the framing, or the neglect to frame the laws which should put down these burnings with a strong hand.

The Planters. The superseding of the windmill by the steam-engine, and the consequent extraction of a larger proportion of juice from the cane, requires more fuel for the evaporation of the juice than the megass, or crushed cane can usually furnish. So that which should have contributed to the supply of the element of water, the tree, is cut down to supply the element of fire. Not content with the destruction of wood on the pretext of the necessity of feeding the fires under their furnace coppers, many planters wage a war of extermination against trees as such. They screen the sun from the canes, and therefore the trees that were planted by wiser men are doomed to fall one by one beneath the blows of the axe. The planters are an educated class, they are usually unremitting in their attention to their estates, and are not ignorant of the importance of the problem; moreover they are the makers of the laws, or the chief constituents of the legislators, and must be held morally responsible for the injury they inflict and permit.

The Administrative and Legislative Bodies.—That which is the duty of the Governments of India and of France is no less the duty of the Government of Antigua. If it be true that the prosperity and even the very existence of Antigua as a sugar colony depends upon its power to cultivate the cane; if the power to cultivate the cane depends upon the quantity and character of the water supply, if this supply is dependant in great measure on the existence of trees, the preservation of the trees is a duty of the very first importance. It is admitted that the owners of land are in fact only occupiers with a life interest in it, that its possession entails certain duties, one of which is to leave it to succeeding generations in as good a condition as it has been received. But the land would be valueless and would degenerate to wilderness and desert without the humid climate which would make its cultivation alone practicable: a desert island could support no considerable population. The owners of land have manifestly no right to ruin the climate, and it is the clear duty of the Government to prevent their doing so. The Government seems to have ignored this duty, and the legislature may be seen employing itself with devising means for the punishment of the negro who steals a single

cane, while the whole inhabitants have practically made a huge conspiracy to rob the island of fifty per cent. of its entire crop. But sins of commission must be laid to the charge of the legislature as well as sins of omission. Fuel must be found for concentrating the sugar crop. That which the megass fails to afford must be supplied by indigenous wood or imported coal. Every encouragement to the consumption of coal is *pro tanto* an obstacle to the cutting down of native wood. It might therefore reasonably be expected that coal would be exempted from every impost, and all possible facilities for its import would be afforded. So far from this being the case the legislature has actually selected coal as an article for taxation, and has thus in effect offered a premium for the destruction of the timber!

The prosperity of every class of the island is bound up with that of its staple production. Moisture means food and employment for the negro, prosperity for the planter, peace of mind and liberal remuneration for the attorney, prosperity for the merchant, the storekeeper, the ship owner, and the banker, and a well-filled treasury chest from which the officials draw their salaries. Even the clergy are not unaffected by the general prosperity. The value of estates is directly influenced by the climate, and once valuable properties now abandoned would by an improved climate be worth many thousands of pounds. It is thus evident that every class suffers from the ruin of the climate, and all are interested in taking the steps needful for its improvement.

Having ventured to point out in what respects the inhabitants have gone astray, it may be expected that some method should be indicated for regaining and retaining the right path, and though the writer is little familiar with this branch of the subject, the following suggestions are offered:—

1. The very first step to be taken is to ascertain the facts. To this end the Governor might appoint a carefully selected Commission composed of practical and scientific men.

2. If the report of this Commission should agree with the opinions quoted in these articles the next step would be to impress all classes with the deep importance of the subject. Among other methods of influencing public opinion the following suggest themselves:—The Governor, by speeches and proclamations should press

the question on the attention of the inhabitants. The editors of newspapers and their correspondents should ventilate the subject. The ministers of religion, some of whom have already become hononrably distinguished by their wise, practical teachings, may very properly employ their great influence in shewing the effects that will follow the denudation of the land of trees. When they have prayed that the kindly fruits of the earth may be given and preserved for their use, so that in due time they may enjoy them, it may not be without profit to teach that such a petition offered when the laws, the observance of which is essential to their production, are systematically broken, is vain, if not actually sinful. The teachers of schools, those on Sunday as well as on other days of the week, should inculcate similar lessons, and those who have to provide books for the use of schools, might properly introduce reading lessons, conveying some such information as has been copied into these articles. It will be needful to *saturate* the minds of those whose practice and tradition have been opposed to the new lessons about to be taught.

3. Legislative action. First.—In the direction of removing all obstacles to the use of coal.

Second.—By encouraging the private cultivation of wood, by exempting all land so planted, from taxation.

Third.—By imitating the French, in planting trees as much as possible in the city. And by planting trees along all the public roads.

Fourth.—By seeing that the highest portion of the mountain land, the crests of all hills, the steep hill sides, and the main water courses are planted. The offer of some small reward might be sufficient to secure this, but if not, legislative provision should be made for the acquirement by the Government for the purpose of planting of all the upper portions of the mountains.

Fifth.—By the appointment of a *suitable* officer for Conservator of Forest and Meteorologist. The duties of such officer would comprise the supervision of the public forests in order that they should remain uninjured; he would see that the laws for the preservation of timber were enforced, and that the groves along the roads were preserved. He would furnish a meteorological report, especially of the rainfall and the relative humidity of the

air, and would collect and disseminate information respecting the best varieties of trees for planting, and the best mode of treating forest land for meteorological purposes, and for profit.

Sixth.—By providing for the gratuitous distribution of young trees of suitable varieties for planting.

Seventh.—By passing and enforcing somewhat severe laws against clearing land by fire, and against the wanton destruction of trees by fire or otherwise.

These reforms cannot be effected without the expenditure of some money, and the writer has long been of the opinion that the public expenditure of the colony is excessive: yet by a wise economy it is probable that the needful expenditure could be met. Other suggestions present themselves, but must be rejected, either because they lack the quality of justice, because they would inflict too heavy a burden for the backs in their present weak condition, to bear, or because they would be too despotic for Englishmen to submit to. It might be urged that the possessors of mountain land unsuited for cane cultivation should be compelled to plant it. Such would in effect be robbing the mountain proprietors for the benefit of planters on the plains. It might be urged that for each acre of canes cultivated a certain portion should be devoted to wood. This would inflict a needless burden on some of the estates composed only of cane land. It might be enacted that as abandoned estates, when covered with grass are more cloud-repellent than cane fields, that the possessors of all abandoned estates should be compelled to plant a portion of them under penalty of sale for the cost of such planting. Such a course seems needlessly harsh, at any rate at first.

The writer has written plainly, with the hope of drawing the attention to this subject, of persons of greater experience and more local knowledge than he possesses. The general adoption of rain gauges in the island is an indication that the question of the rainfall is now considered important; but the registration of the rainfall taken alone resembles the action of an invalid who should employ his time in feeling his pulse, whilst neglecting all means of curing the disease, which left unchecked, will result in CERTAIN DEATH.

THE INTERNATIONAL SUGAR QUESTION.

Our colonial friends will be glad to see, by the following Editorial leaders, from the French papers *Journal des Fabricants de Sucre*, and *Sucrerie Indigéne*, that the international sugar question is rapidly approaching a crisis. The first evinces a liberality, and an honest appreciation of the position, which is much to be commended. The last seems puzzled, but we are inclined to think, wilfully so, when he asks why the Planters of Jamaica make common cause with the refiners of Great Britain against the refiners of France, with whom, as he says, they have no direct competition, and why they attack the French sugar *manufacturer*, who enjoys no bounties on the export of raw sugar. We have not noticed the "attack" of which he speaks; but it might not unnaturally occur to most people that without their raw sugars, which either do or ought to participate in the benefits derived from the bounties on export of the refined, the refiners would have some difficulty in prosecuting their trade, which is now so damaging to our colonial planters, and so costly to the taxpayers of France. We should not have much further to seek for our colonists' opposition to the refiners.

While admitting that the raw sugar manufacturer *may* indirectly participate in the export bounties on refined, it can scarcely be doubted that if their Government, in conjunction with the Governments of the other sugar producing countries of Europe, can agree to put an end to all drawbacks, and the English market be open to all on equal terms, they will get much better prices for their products than they can now screw out of their own refiners, on whom they are now, of necessity, so largely dependant.

"The *special* English press has not allowed our recent remarks on the fiscal system of sugars to pass unnoticed, as the first article in our issue of the 11th of June has had the honour of an entire reproduction, whilst they are the object of commentaries, which we would not speak of if our *amour-propre*, as the author, was alone concerned. The fact is that the question is burning; and we shall see by the important step which the refiners and British planters have just taken, that the abolition of the duties by Great

Britain has not had the effect of lessening her interest in that question, and that the country remains more than ever determined on the performance of the old contracts of 1864. The step to which we allude, and which we report in another place, acquires a particular gravity by the presence of all the Members of Parliament, representing the towns in which sugar refining is carried on, on a deputation to Lord Derby, when his excellency, warmly solicited, gave his promise that strong representations should be made to the French Government, who have the question now under consideration.

What are our Government going to do, and what means has it for complying in any material degree with the demands of the English Government, limited for the moment to the strict execution of the Convention of 1864? We doubt these demands, coinciding with the long parliamentary vacations, will have no more effect than preceding ones, and will come to no practical result. It requires less knowledge, however, to be convinced that a solution of the international sugar question cannot be long deferred, and we are happy to see organs, so well accredited as the *Produce Market Review* and *The Sugar Cane*, sharing the opinions we have expressed. It is not, therefore, in vain that we have called public attention to the part which certain sugars play, such as those of Austria, protected by their legislature, and which in England hold a privileged place on the raw sugar market, at the expense of producers in general, analogous to that held by our refined sugars.

Must we, says *The Sugar Cane*, answering the question which we put, close our ports to all sugars which enjoy a bounty on export? A delicate question, which involves all those which may be invoked in favour of commercial liberty, which, we must admit, is subject to the most evident infractions, and which clearly shows the existing chaos of the sugar legislation. Free trade in sugar is only in fact a word, which, in the circumstances, corresponds to free importation, or rather free consumption, since British refiners and colonial producers are sacrificed in the interest of the consumer. It is, therefore, in support of an economical heresy that the British Government should refuse to interfere in commercial

treaties. This policy of abstention may be the ruin of the national producer, and have no other effect than that of placing the English sugar trade at the mercy of the foreign. Really, practical men, familiar with the commercial interests of the country, ought to comprehend that it is the interest even of the consumer that the commerce and industry of the country should flourish, and be carried on freely, that is on conditions of perfect reciprocity with other nations.

Such in substance, as will be seen in another part of this paper, is the language of the special article of which we speak; and we feel it, on our part, too true to attempt its confutation. France, Austria, and Belgium may, by different contrivances, make their profit by it, but an important industry cannot always repose on artificial bases, and every consideration demands that an end should be put, as soon as possible, to a system which, under the mask of liberty, enables protection to practice what is universally condemned. Only we do not wish that France should enter upon this liberal campaign alone: ready to reject the bounties by which she profits, and which are the objects of such just complaints,—if the sugar nations of Europe with which she has to compete in the English market, or elsewhere, testify the same goodwill, an arrangement may be come to. That is what the English papers, in the interest of the sugar trade, advocate, and it is a happy augury for measures of intervention.

England has established freedom of importation; let us establish freedom of exportation by the effective suppression of privileges, and let sugar-producing Europe come to an agreement in all in which the producers are interested.

The report of the sitting of the National Assembly on the 4th of this month, which we have just read, contains—opportunely for the discussion of the budget (chap. 4, encouragement to agriculture)—an interpellation by M. Paris, deputy of the Pas de Calais, upon the sugar system. After having referred to the vote of the 12th March last, relative to the application of the *practice*, as well as the different interpellations which have taken place before the Parliament of Holland, and in the English House of Commons;—

after having also made allusion to the Belgian frauds proceeding from the vicious sugar system which exists in that country—all facts known to our readers—M. Paris demanded, of the French Government, what are its intentions on the subject of the *practice*, and what the negociations which ought to be opened with foreign powers for the renewal of the treaty of 1864. This is the answer of M. Grivart, Minister of Agriculture and Commerce :—

"Gentlemen, in view of the execution of the resolution which you adopted on the 12th March last, a regulation upon the *practice* of sugar factories has been prepared by the administration of indirect contributions by order of the Minister of Finance.

This regulation is sent to the Council of State, who ought, first, to give its advice in this matter, for it belongs to a regulation of public administration ; and by reason of the extreme importance of the regulation, the question will be submitted to the united sections of finance, agriculture, commerce, and public works. As soon as the regulation, so prepared, shall have been adopted, negotiations will be opened, under the charge of the Minister of Foreign Affairs, with the contracting Powers of 1864. The end which these negociations will strive to attain—that which will be pursued by the Government, with the greatest solicitude, will be to obtain, by the renewal of the Convention of 1864, the adhesion of the contracting Powers to the principle of *practice*,—in all cases, to a system which shall put an end to the bounties on the exportation of sugar. When these negociations shall have been completed—when the regulation, carefully prepared by the Administration, shall have been definitely adopted, we are bound to believe that the Government will recognise the necessity of submitting to the Assembly a project modifying, in certain points, our sugar legislation.

This project will be ready to lay before you after the vacations, when you resume your labours." (Hear, hear.)

M. Paris declared himself satisfied, but as ten months only remain for the renewal of the treaties of 1864 he urged the Government to put this time to profit, and vigorously to push on the negociations."

* * * * * *

Premium for Improvement in Extracting Juice from Cane.

In the Chamber of Agriculture of La Poit-a-Pitre, (Guadeloupe,) M. E. Souqes discarded the idea of always applying, in critical circumstances, to the Administration, that can do nothing. He admitted, however, that the crises of alarm are not uselessly raised. The situation is not a pleasant one he acknowledged, but the peril is not imminent. If the cultivation of the cane suffers from the low prices of sugar, its competitors, the beet root growers are, perhaps, in a still more disastrous condition. These considerations should not prevent us from availing ourselves of the opportunity of improving our method of extracting the juice from cane. Let the Chamber appoint a Commission, charged to ascertain if 100,000 francs can be procured, in part from the cultivator, in part from the trade, and in part from the Colony, to be offered as a premium, (independently of any patent rights his invention may entitlte him,) to the discoverer of an economical process of manufacture, by which a return of 80 per cent. in juice shall be obtained in place of 68 per cent., the result of the present method of working.

The Chamber having being consulted adopted the proposition, and a ballot being taken for the nomination of the Commission, which was fixed at five, showed a majority for M. M. A. Duchassaing, E. Souque, B. Luhaye, E. Dubos, and Meugnot.—*Journal des Fabricants de Sucre.*

"According to our honorable contemporary, the *Produce Markets Review*, of London, a deputation composed of the West India Committee, members of the Sugar Refiners' Committee of Great Britain, and members of Parliament representing the ports and towns interested in the sugar trade, was received in audience by Lord Derby, Minister of Foreign Affairs, on Friday the 24th July, and presented the following Petition signed by said members of Parliament :—

"To the Right Honorable the Earl of Derby.

"The undersigned members of Parliament respectfully beg to call your Lordship's attention to the injury caused to the sugar

refiners of Great Britain, to the producers and importers of colonial sugar, and consequently also to her shipowners, by the bounties which the French exporting sugar refiners enjoy, and they beg to make known to the Government of Her Majesty the necessity there is of addressing a note to the French Government, without delay, insisting on the immediate execution of the Convention concluded in 1864, with the object of abolishing these bounties; or at least that France shall establish, in the present year, refining in bond, a system which has been recommended by Her Majesty, and accepted by the French Government, as the most efficacious remedy."

Mr. G. H. Chambers explained to Lord Derby the serious injury caused to the West Indian interests by the importation of French refined sugar, which, by receiving a large bounty on its exportations from France, enters into unfair competition with the products of these countries.

Mr. Gadesden, speaking afterwards in the name of the refiners of Great Britain, remarked: that the Convention was concluded in 1864, at the solicitation of France; but that, under different pretexts, that country from the beginning to the present time, always neglected to observe the terms of the contract. He hoped, therefore, that the Government of Her Majesty, availing themselves of the law, which is still in force, would demand from France the execution of the treaty, and take energetic steps towards that end. He showed the urgency of the question by the fact that the Convention expires next year, when it would become much more difficult to obtain an equitable arrangement.

After several other detailed explanations, Lord Derby replied: That the deputation has established its position in an excellent manner, and that its request will be put in writing and sent to Lord Lyons; that at the same time he himself would address a despatch to his Lordship requesting him to attend to the question without delay, and press the solution on the French Government.

It is, therefore, probable that at this hour our Government is engaged with it. What will be its response to the communication of the Ambassador of Great Britain, and how soon shall we know

it? But, in the meantime, we ask ourselves how it happened that, after Sir Stafford Northcote said publicly in Parliament (V. Vol. 8, p. 519) that a change in the basis of the Convention, with respect to refining in bond, was impracticable, as late as the 1st July, and that the spirit and letter of this Convention were opposed to each other, Lord Derby should, two months afterwards, propose this same system as a basis of new arrangements.

We ask ourselves also, why the planter of Jamaica should make common cause, with the refiners of Great Britain, against French refineries which for them are not direct competitors. They have no better right to attack the French sugar makers inasmuch as the latter enjoy no bounty on the exportation of raw sugar. The Belgian, German, and Austrian makers, on the contrary, do enjoy undeniable bounties, and supplant them in the English markets. It is therefore to them, and them only, that their complaints should be addressed."—*Sucrerie Indigéne.*

ON THE EXPANSION OF SUGAR SOLUTIONS BY HEAT.

By P. CASAMAJOR.

(From the American Chemist.)

In a paper on "Testing Sugar Solutions," published in *American Chemist* for October and November, 1873 (vol iv. No. 4, p. 127; No. 5, p. 161), I had occasion to convert the densities of sugar solutions at various temperatures into the corresponding densities at the normal temperature of 17½°C. To effect these conversions I had adopted the table given by Mandelblüh in *Leitfaden zur Untersuchnung der Verschiedhen Zuckerarten*, p. 29, without having any misgivings at the time regarding the inaccuracies it might contain. I first became aware of the existence of grave errors in this table since the publication of the above paper, while endeavouring to discover a process for the direct determination of the water contained in commercial sugars by means of arcometers. The description of this process I reserve for a

future communication, and now merely mention this subject to say that the results obtained were so discordant when operating at temperatures very different from 17½°C., that I was forced to conclude that no reliance could be placed in the table for correction of temperature given by Mandelblüh. As soon as this conclusion was reached, I determined to ascertain experimentally the expansion produced by heat on sugar solutions, limiting my observations to thin solutions that can be tested by being placed directly in the tube of the saccharometer.

In pursuance of this plan, I determined the expansion of water and of various sugar solutions up to the one containing 23 per cent. of sugar. These determinations were made several times for each solution by taking the specific gravity, and by using a *dilatometer*. In all cases two observations were made for every solution, one at + 4° C., or a little above that point, and the other at nearly + 40° C. The total expansion, reduced to the unity of volume, was then divided by the difference between the temperatures of the two observations, and the result was considered as the coëfficient of expansion of the solution under examination for 1° C. Thus if we call V the volume of the solution expressed in cubic centimetres; e, the total cubic expansion, also in cubic centimetres; t_0 and t the temperatures of the liquid at the time of the two observations, we shall have for a, the coëfficient of expansion,

$$a = \frac{e}{V(t - t_0)}$$

The researches of Herrman Kopp and those of Dr. Matthiessen have shown that the coëfficient of expansion of water increases as the temperature rises. If this result is admitted, it becomes evident that the above formula cannot be correct, but for temperatures ranging between 5° and 45° C., the error is not appreciable.

To establish the coëfficient of expansion of water and of sugar solutions, observations were made: 1st, with a specific gravity bottle; 2nd, with a pipette and beaker glass in the manner described by me in *American Chemist* for October, 1873 (vol. iv. p. 129); 3rd, with a *dilatometer*.

The results found by these three methods agree very closely,

but those given by the dilatometer are the most satisfactory in relation to constancy, while the process employed when using the dilatometer, although it takes more time, leaves no room for errors which may occur with the other two methods. The principal cause of error when the specific gravity is used is that the temperature varies between the time of its observation and that of filling the bottle or pipette; that while the density is being taken on the balance for the minimum temperature, vapours in the room condense on the bottle or on the pipette and beaker, and that while the maximum temperature is being observed, considerable vapours escape from the beaker glass.

In view of the advantages presented by dilatometers when properly used, I propose to give directions for graduating them, and to describe the manner of observing expansions by processes that leave no room for error.

A dilatometer is a glass flask, the neck of which is very narrow compared to the volume of the bulb. This neck should be divided as finely as possible, which may easily be done by a plan we shall presently describe, which is applicable to the graduation of glass vessels of all kinds, and may consequently prove useful even to those who have no occasion to use a dilatometer.

A flask with a neck sufficiently narrow is not generally found at the dealers, but can be readily made at the glassworks. The best plan to obtain one or two of the requisite shape and size, is to get the glassblower to make four or five, which takes but a short time, and to pick out the most suitable. To graduate a flask of this kind, it must, in the first place, be filled with water up to a point on the neck, which will be the 0 of the scale. The volume of the flask up to this point must be determined and noted down for future use. The neck of the flask above the 0 point may be divided into cubic centimetres and tenths by sticking on the neck longitudinally a strip of paper about 5 millimetres wide, on which a line is drawn corresponding to the 0 point already determined. We now add with a fine pipette 1 cubic centimetre to the liquid in the flask, which causes it to rise in the neck to a point which we mark by another line across the strip of paper. Afterwards we

add another cubic centimetre, and make another corresponding mark on the strip of paper, and repeat the same operation until we have divided the neck as far as required. We may now obtain the tenths of cubic centimetre, by dividing into ten equal parts the space between two of the transversal lines. If any portion of the neck should not be cylindrical enough, it would be advisable to divide the space corresponding to a cubic centimetre, by means of a pipette, into halves or fifths, and afterwards to divide the intervals, so that every division may represent $\frac{1}{10}$ of a cubic centimeter. I have said that the cubic centimetres are marked on the strip of paper by transversal lines running across the paper: in the same manner the halves may be conveniently represented by lines running only partially across, and the tenths by dots on the strip. It is now an easy matter to transfer the divisions to the glass by cutting through the strip of paper with a sharp file, which must be previously dipped into spirits of turpentine, petroleum, or naptha, to prevent the file from cutting off the neck of the flask. In transferring the marks on the paper to the neck of the flask, we may mark the cubic centimetres by lines as long as the width of the strip, while the halves may be indicated by lesser lines, and the tenths by the shortest lines, which may be made with a file. After all the marks have been transferred to the neck of the flask, the strip of paper is removed, and the marks made by the file are distinctly seen. To observe expansions with the dilatometer, it is filled to about the 0 point with the liquid to be observed, and placed in a large glass vessel such as a battery jar, which must be filled with water at a temperature of 4° C., or a little above that point. The level of the water in the glass jar should be higher than that of the liquid in the dilatometer, so that the liquid in the flask be entirely submerged in the liquid of the jar. This being the case, if the liquid in the jar be kept at a uniform temperature for a sufficient length of time, the liquid in the flask will acquire the same temperature.

To observe the temperature of the liquid in the jar, a thermometer should be placed in it; a stirrer should also be added to keep the different layers of liquid at the same temperature. It

requires a little attention to keep the liquid in the jar at a uniform temperature. A little ice or ice-water was to be used from time to time to keep the temperature of the liquid from rising. If the temperature becomes too low, the addition of warm water will be necessary. The stirrer should be used every few minutes. It is difficult to specify how long the dilatometer should be immersed. I have allowed mine one hour, which is more than sufficient. If, before taking out the dilatometer, it should be noticed that the liquid does not stand at 0, a little should be added or taken away with a fine tube, until the liquid stands at 0. In case of an addition it is well to let the liquid stand a little time before observing again whether it stands at 0.

The dilatometer, after the completion of the first observation, should be taken out. To make the second observation, the jar must be filled with water having a higher temperature, say 45° C., for about an hour, observing the same precautions as before.

As the action of heat expands the liquid in the dilatometer, it rises in the neck of the flask, and care should be taken to keep the water in the jar at a higher level than the liquid in the flask.

The expansion of cubic centimetres observed, divided by the number of cubic centimetres contained in the dilatometer up to the 0 point, and by the difference of temperature of the two solutions, gives the coëfficient of expansion, or the expansion of one cubic centimetre of the liquid for a rise of 1° C.

The intervention of a glass jar to bring every part of the dilatometer to a uniform temperature, and the allowance of sufficient time to let this action take place, are two important conditions to obtain accurate results. There is no doubt that many of the discordant results obtained by observers are due to a neglect of these two points. The introduction of a thermometer and of a stirrer in the dilatometer itself may lead to loss of liquid, and require a larger neck than is consistent with delicacy of observation.

In the preceding remarks I have spoken of the expansion of the liquid in the dilatometer without keeping account of that of the flask itself. The expansions thus obtained are the relative expansions of the liquids. To obtain the absolute expansion, we must

add to the relative expansion the absolute expansion of glass, which is 0·000026 for 1° C. The relative expansions of sugar solutions are, however, those needed in these researches, whose main purpose was to correct the indications of a glass areometer.

As a result of many observations, I obtained for the relative expansion of 1 cubic centimetre of 1° C. 0·00021 c. c., and for the relative expansion of 1 c. c. of sugar solution of 23° Balling for a rise of 1° C. 0·00023 c. c. For the solution containing 11½ per cent. of sugar, which is a mean of the other two, I obtained 0·000215 instead of 0·00022, which is the mean of the coëfficients of expansion. As this difference and those obtained in examining other solutions are not considerable, I have assumed that the coëfficients of expansion between 0° Balling and 23° Balling are intermediate, as follows:—

Degree Balling.	Coefficient of expansion.
0°	0·000210
6°	0·000215
12°	0·000220
18°	0·000225
23°	0·000230

Besides solutions of refined sugars, I tried muscovadoes, meladoes, and molasses, and found that the expansions corresponded to those of pure sugar of the same density.

In the table of expansions of water by Herrmann Kopp (H. Watt's *Dictionary of Chemistry*, vol iii. p. 58) we find that a volume of water equal to 1· at 0° C. is equal to 0·99988 at 4° C., and at 45° C. is 1·00954; the difference between the last two numbers is 0·00966, which is the expansion for 41° C. Dividing the number 0·00966 by 41 we find 0·000235 for the expansion of water for a rise of 1° C. If from this quantity we subtract the the cubical expansion of crown glass, already given, we find 0·000235 — 0·000026 = 0·000209, which is materially the same as my result.

From the table of Mandelblüh, already cited, we extract the following:—

Per cent. of sugar.	Specific gravity corresponding.	Expansion in glass.
1°	1·0000	0·00007
5°	1·0196	0·00007
10°	1.0401	0·00009
15°	1·0612	0·00011
20°	1·0832	0·00019
22°	1·0924	0·00023

This table presents this curious peculiarity, that while the expansions of the first portion differ widely from those I have given, they approach nearer to my results towards the end, and finally, at 22°, the expansion given corresponds to what I found for 23°. As my repeated tests leave no room in my mind for doubting the accuracy of my results, I must suppose that the person who compiled this table took for the solution containing 22 per cent. of sugar the right coëfficient of expansion, but, having adopted a wrong number for the expansion of water, he afterwards obtained the expansions of intermediate solutions by intercallation, and made a table in which the error for any solution may be said to be proportional to the difference between 22 per cent. and the percentage of sugar in that solution.

The main purpose of these researches being to correct the indications of the Balling areometer used in my method for testing sugar solutions, by bringing the reading of the instrument at any temperature to what it would be at 17½° C., we must now apply the coëfficients we have obtained to these corrections.

In the *American Chemist* for February, 1874 (vol iv. p. 286), I have shown that if Beaumé's areometer was a geometrical cylinder, and if the division in degrees was prolonged to its lower extremity, there would be 144° from the 0 downwards.

In the same manner, if we bear in mind that 1° Beaumé equals 1·805 Balling,* we may see that Balling's areometer will have

* This formula, which I gave in American Chemist for October (vol. iv. p. 129), affords accurate results when applied to solutions between 5° and 15° Balling, which are those mentioned in connection with my process for testing sugar solutions. For heavier solutions, the results in percentage of sugar are too weak. The following formula gives the correspondence of degrees

$144 \times 1{\cdot}805 = 259{\cdot}92$, or nearly 260° from the 0 downwards, so that if we place a Balling areometer in pure water at 17½° C., it will sink to 0, and there will be a volume equal to 260° below the surface. We may find the expansion of this volume of water, taking 1° Balling as unity, by remembering that the expansion of 1 cubic centimetre of water for a rise of 1° C. is 0·00021 c. c., consequently that the expansion of 1° Balling is 0·00021°, and that of 260° is $260 \times 0{\cdot}00021 = 0{\cdot}0546$. This quantity, 0·0546, must be added to the indications of the areometer at this part of the scale as many times as there are degrees C. above 17½°, and subtracted as many times as there are degrees C. below 17½°.

If now we place the Balling areometer in a solution containing 23 per cent. of sugar, it will sink to 23° at 17½° C., and there will be below the surface 260°—23° = 237°. In the same manner as before, and remembering that 1 c. c. of the solution at 23° has an expansion of 0·00023 for an increase of temperature of 1° C., we find the expansion of the volume represented by 237° Balling to be $237 \times 0{\cdot}00023 = 0{\cdot}0545$. We have thus reached this remarkable result that the correction for temperature is the same at 0 of the Balling scale as at 23°. It follows that it must also be the same for all the intermediate degrees of the scale, and consequently we are enabled to make the correction for temperature in a very rapid manner by the following table, in which the first column shows the difference between the temperature observed and 17½° C., and the second column the number, which is a multiple of 3·0545,

very approximately between 0 and 45° Beaumé: $D = 1{\cdot}8d + 0{\cdot}002d^2$, in which D is the percentage of sugar or degree Balling, and d the Beaumé. I said in the same paper that Balling's areometer has an even scale. To this it has been objected that if Balling's areometer represents the percentage of sugar, it cannot be an even scale, which is true, for the formula $D = 1{\cdot}8d + 0{\cdot}002d^2$ will not give a straight line, but a curve. I must say, however, that all Balling's areometers I have found, either made in this country or abroad, have an even scale. At any rate for an areometer ranging from 5° to 15° Balling, if we make every degree equal to 1·805° Beaumé we may have an even scale whose indications do not differ appreciably from one representing the percentage of sugar in a solution.

which ought to be added to the indications of the areometer if the temperature observed is above 17½° C., and subtracted from it if the temperature is below 17½°. The decimals have been carried to the thousandths; although the hundredths are sufficient for practical use.

Difference between the temperature observed and 17½° C.	Quantity to be added or subtracted from degree Balling.
1	0·054
2	0·109
3	0·163
4	0·218
5	0·272
6	0·327
7	0·381
8	0·436
9	0·490
10	0·545
11	0·600
12	0·654
13	0·708
14	0·762
15	0·817

By means of the data given in this paper it will be an easy matter for any one to correct the errors into which I was led by the adoption of Mandelblüh's table. I merely wish now to correct two tables, one of which will be found in the number for October, 1873, vol. iv. p. 128, and the other in the November number, vol. iv. p. 163. The first-mentioned table is to enable persons who have a Duboscq saccharometer to use Ventzke's process, by means of an areometer giving the specific gravity 1·063 at 17½° C. At other temperatures the indications of the areometer should be as follows:—

Degree Celsius.	Specific gravity.	Degree Celsius.	Specific gravity.	Degree Celsius.	Specific gravity.
8	1·0652	15	1·0637	22	1·0621
9	1·0650	16	1·0634	23	1·0619
10	1·0647	17	1·0632	24	1·0617
11	1·0645	18	1·0630	25	1·0615
12	1·0643	19	1·0628	26	1·0612
13	1·0641	20	1·0626	27	1·0610
14	1·0639	21	1·0623		

This table is calculated with the coefficient of expansion 0·00022.

The other table which appeared in the November number gave the coefficients as varying from 0·00024 to 0·00029. I must now substitute for these the sole coefficient 0·00023.

Brooklyn, May 20, 1874.

THIS SEASON'S PRODUCTION OF FRENCH SUGARS TO THE END OF JULY.

The French official journal has published its table of the production and movement of indigenous sugars to the end of July. The nett production is 374,907,612 kilos. against 388,453,917 the previous season.

The development of the various kinds manufactured in the course of the season is given as follows :

	1873-74	1872-73
Below 7	2	1
From 7 to 9	31	32
,, 10 to 12	18	22
,, 13 to 14	5	11
,, 15 to 18	2	2
,, 19 to 20	1	0
White powders	38	30
Refined	3	2
	100	100

In connection with this return M. Dureau has the following observations in his paper of the 20th inst. :—

"We see that a smaller proportion of brown sugar has been made this season, but a larger proportion of white powders, a great quantity of which still encumbers our *entrepôts :* in fact the stock of these sugars on the 31st July was 27,230,145 kilos. against 28,132,242 kilos. of brown. We should expect to see a more limited production of this particular kind, if it does not meet with greater

favour in France, or if a larger outlet is not found for it elsewhere. This unfavourable situation for white powders must be aggravated by the new facilities for exportation which Belgian sugars of the same class are about to receive in consequence of the ministerial decision reported in our issue of the 30th ult.—a decision which accords to these products a credit of 51·13 francs, which is the same as for refined. Our makers will therefore have to give less work to their turbines, or endeavour to correct the result of their perfected manufacture by mixtures, or artificial practices which are the negation of progress in industry, and which are, in every case, the strongest demonstration that can be furnished of the absurdity of our legislation.

"The other parts of the table explain themselves. We cannot, however, refrain from pointing, yet again, to the grievous stagnation of our exports which this season presents—a dimunition of about 23,000,000 of kilos. upon the preceding one. The difference explains, at once, both the reduction of home consumption, and the plethora of our *entrepôts*, which contained on the 31st July nearly 34,000,000 more than last year.

"However, notwithstanding this situation, and though little time remains for reducing the excess of our stocks, there is no occasion, we think, for much alarm. We deduce from some significant facts, elements of confidence, which our manufacturers are in sore need of, and with which we desire to inspire them. In England, consumption makes enormous progress, at the rate of something like 75,000 tons a year. Combined with a dimunition in imports, this consumption is such, that the surplus in stocks, but lately so considerable, is not more, at this moment, than 12,000 tons. In the United States, the consumption in the month of July was 62,838 tons against 46,180 tons in July, 1873, and 45,820 tons in July, 1872. And this is not an exceptional fact, since the consumption for nine months is 397,486 against 343,178 tons in 1873—an excess of 54,000 tons. If this progression should continue it will give an increase of 93,000 tons in the year. Thus we need not be astonished that the Americans, with a view to meet these enormous demands, are seriously occupied in studying the various sources of

production, and may be, in a little time, buyers on all the markets of the world. Even in Germany the situation is favourable. The stocks there are reduced to insignificance; and the consumption, by annexations, and faciliated by greater comfort and new habits, makes remarkable progress. For the twelve months ending in June last, the consumption in Germany was 295,002 tons against 260,779 in 1873, and 209,626 in 1872. We have therefore only to look to last year for an increase of about 35,000 tons. In Austria the progress of consumption is also very great, and we can hardly doubt that, with few exceptions, an amelioration in this sense is taking place in other countries of Europe.

With a consumption which, in Europe and the United States, increases notoriously at the rate of 200 millions of kilos. in a year, it is difficult not to feel reassured for the future of sugar, and not to believe in an improvement, perhaps nearer than people are generally inclined to admit. This improvement will be so much the more sure that the crisis of last year, provoked by the increase in the price of coal and various other causes, has paralysed for a while the swing of production, which will not regain itself this year, but which will doubtless lead to more circumspection than in the past. The retardation, at any rate, has given us time to think, and will have produced useful reforms, as well as needed transformations. The cultivation of the beet, as well as the *manufacture*, have been the object of greater attention, and we have sought to find, in a more economical use of labour, benefits which we may find it impossible to realise in the *prices* of sugar alone. If production stands still, consumption will overtake it, and if the first has, for a long time, been in a state of relax, to which hard trials have brought it, we shall not have much longer to wait before we see a change. We may cease, indeed, for a year or two, to increase the means of production in our old factories; but this must produce in the world a veritable scarcity of sugar.

A scarcity of sugar! The word may appear paradoxical, in the circumstances in which we are placed; and we have only to cast a glance over the stocks to convince ourselves that we are yet far

enough from such an event. Most people, moreover, will recognise in the case, where production goes on as it does now, that some time must elapse before we can renew our energies, and march *pari passu* with the consumption, now daily increasing. When that time arrives, few countries will be able to profit by it as much as beet growing Europe, especially as France, which, in regard to extension of the power of production, holds the first place. A rapid glance at the situation of the different sugar producing countries is sufficient to convince us of this. Let us look at Cuba first. The production of that great sugar island makes no progress. It undergoes variations, it is true, from good or bad harvests, but so long as Cuba shall remain a prey to war, and retain the institution of slavery, her producing energies will be paralysed and we need not reckon upon that island to supplement the new wants of Europe, and the United States. Brazil, at this moment, prefers the cultivation of coffee to sugar, which is more troublesome and less remunerative. The production of Java is favoured by situation, but its resources are limited. That of Egypt, which frightened us for a brief period, is circumscribed by the many wants of the Viceroy, and the vices of his administration. Louisiana is in rapid decay as respects sugar production, with her blacks and whites in antagonism, and political disorganisation, a consequence of the civil war. The production of the Antilles, in general, cannot spread far for want of hands; that of the Mauritius and Reunion is limited by drought and a scarcity of soil suited to the culture of the cane. Certain new countries remain, such as the colonies of Queensland and Port Natal, which may produce the sugar cane of the future, but time must pass before these countries can have much weight in the general production; and that time the growers of beet root will know how to turn to profit.

It is not, then, without reason we assign to this young branch of sugar industry the care of providing for the increasing wants of consumption, and that, in the midst of a cruel crisis, we endeavour to reanimate its confidence in the future. We ought to follow, with no less interest, the progress of exotic industry, especially in our own colonies, where the skilful cultivators have saved those countries from irretrievable ruin."

WILL SUGAR GROWING PAY IN THE SOUTHERN DISTRICTS?

(From *The Queenslander*, of May 16th, 1874.)

We live and learn. I have been engaged in sugar culture and manufacture in the West Indies, in America, and in Australia, off and on since the year 1846. In those countries, and during that time, the people engaged in the above-named industry have been invariably called sugar planters, in the West Indies simply planters. "P. X. N." in explanation, enlightens us, however. He says a planter is a person who plants cane and lets it cultivate or take care of itself; but that a cane farmer is a man who cultivates properly. All Southern planters, with myself, were awfully riled at "P. X. N." for saying that we would all break banks; but after his second letter, explaining that we are not planters at all, but farmers, that makes all the difference. If I only knew who this "P. X. N." was, I would like to shake hands with him for his second letter, explaining that in his first he meant to convey the intelligence that good cultivation or farming would pay, but that bad cultivation or farming would not pay. He fully endorses my opinion, and not mine alone, but all agriculturists of my acquaintance.

Now "P. X. N.," how could you be so playful, you funny man, as to say that I had taken up the gloves for bad farming? when in that letter of mine I tried, in my vanity, to show that I cultivated well and deeply, and kept my cane innocent of weeds, and not only I, but many other Southern planters did so likewise, some of whom I enumerated. But there I go again: when will I learn common sense? How can we be planters, and at the same time cultivate well? but belay that. And now for the rule-of-thumb business.

Dear "P. X. N.," I plead guilty; I am a rule-of-thumb man, for I never used litmus paper or any other test in my life.

On the Orange Grove Estate, Trinidad, on which the largest crops and the best sugar in the island was made, I had three years'

steady training as a planter; but no one there dared to use the simple tests you speak of, on pain of being laughed at, if not expelled the boiling-house as an incompetent. And this feeling prevailed throughout all the West India Islands, also the sugar growing American States; so that we had to graduate through downright plodding, practical experience.

In contrast, it is refreshing to note how the Queensland sugar boiler is trained and fitted as if by magic to manage (damage) the estates of some of our amateur sugar planters. A planter—I ask pardon, a farmer—a friend of mine, none of your rule-o'-thumb men, but a real test man, tells me he can manufacture a dozen sugar boilers every morning before breakfast, if he likes, and that he makes them out of any kind of man, or one of any colour. He can make first-raters out of men having barely capacity to drive bullocks, by the simple test process. I saw him operate upon a Kanaka; one hour and twenty-five minutes did the business. My friend had no trouble in teaching "Koroo" the litmus test for liming, as he knew blue from red. The striking by the thermometer came rougher on the islander, he not being supposed to have capacity sufficient to drive bullocks; in short "Koroo" could not read the figures on the thermometer; but the difficulty was overcome by my ingenious test friend tying a blue thread (all true blue tests, you observe) round the thermometer at what he called the striking point; and "Koroo" struck ile, I tell you, or something like it.

My friend the test plant—farmer I mean—has just informed me that next morning he danced on the test-struck cooler. No wonder you can afford to be merry, you test plan...farmers.—Adieu!

R. Muir.

REDBANK, QUEENSLAND.

Messrs. Rice Brothers' sugar-mill, at Redbank Plains, was a centre of attraction to many holiday folks on Monday last, as an experimental crushing was expected on that day. Although it will be some days yet before all the machinery necessary for

the perfect manufacture of the article will be in its place and properly connected, the works were yet so far advanced on Monday as to admit of a trial of the engine and crushing-mill. The start was fixed to come off at two p.m., and by the time dinner was disposed of—for which ample provision had been made by Messrs. Rice, for all comers, in a large marquee specially erected for the purpose—a sufficient head of steam was on to test the machinery. By this time, also, the company present was still further increased by a large arrival from town, and all being in readiness, the eldest daughter of Mr. H. Rice proceeded to perform the "christening" ceremony with a few appropriate words, naming the works "The Rose." Steam was then immediately turned on, and the mill started on its work, everything going admirably at once, showing the skill and care which had been taken in its erection by the superintending engineer, Mr. William Stirling, of Doughboy Creek, who was warmly congratulated on the issue of his work. The first to pass through the rollers were a few splendid-looking canes, taken at random from a five-acre patch of Mr. Gardiner's, which gave a density of 8°. A ratoon cane from the same place gave 7½°. Some cane of the Messrs. Rice was then put through, the density of which proved a little over 8°. The cane is not yet sufficiently matured, and in a month or so will give a much higher density, it being intended not to commence crushing generally until August. "Success to the Rose Sugar-mill, and prosperity to its public-spirited and energetic proprietors" was then drunk most heartily, the pluck of the Messrs. Rice in entering on such an undertaking being very warmly spoken of. The residents of the Plains, as well they may, feel a most lively interest in the success of the mill, of which no one who was present on Monday and witnessed the success of the start felt the least doubt, more especially as on either hand was to be seen the raw material growing in the greatest luxuriance. On the completion of the works, before handing them over to the proprietors, Mr. Stirling—who is also a practical sugar-maker—will manufacture a quantity of the article for the purpose not only of proving the completeness of his work but also to initiate the Messrs. Rice into the "art and mystery" of sugar-making.

Those present on Monday urged strongly the necessity of the Government continuing the road for ten or twelve chains across the Melon-hut Reserve, a very marshy piece of ground, and at which it at present stops short, having been made by the late Road-Board to that point, for the convenience of farmers drawing cane to the mill. A petition to the Minister for Works is now being got up and signed for the purpose. As we have stated, the Plains farmers were very satisfied with what they saw on Monday, and confidently look forward to a bright future for the district. The suitability of the Plains for the growth of the cane being already assured, that crop will soon supersede cotton; and the erection of other mills at no distant date for the requirements of the district is anticipated.—*Queenslander*, of May 30, 1874.

BRITISH ASSOCIATION.

The forty-fourth annual session of the British Association commenced on Wednesday, the 19th inst., at Belfast. The opening meeting was held in Ulster-hall, at eight o'clock, when Professor WILLIAMSON, F.R.S., vacated the presidential chair in favour of Professor JOHN TYNDALL, F.R.S., D.C.L., LL.D., F.C.P.S., &c., who delivered the following address:—

An impulse inherent in primeval man turned his thoughts and questionings betimes towards the sources of natural phenomena. The same impulse, inherited and intensified, is the spur of scientific action to-day. Determined by it, by a process of abstraction from experience we form physical theories which lie beyond the pale of experience, but which satisfy the desire of the mind to see every natural occurrence resting upon a cause. In forming their notions of the origin of things, our earliest historic (and doubtless, we might add, our prehistoric) ancestors pursued, as far as their intelligence permitted, the same course. They also fell back upon experience, but with this difference—that the particular experiences which furnished the weft and wool of their theories were drawn, not from the study of nature, but from what lay much closer to them, the observation of men. Their theories accordingly took an anthropomorphic form. To supersensual beings, which, "however potent and invisible, were nothing but a species of human creatures, perhaps raised from among mankind, and retaining all human passion and appetites,"* were handed over the rule and governance of natural phenomena.

* Hume, "Natural History of Religion."

Tested by observation and reflection, these early notions failed in the long run to satisfy the more penetrating intellects of our race. Far in the depths of history we find men of exceptional power differentiating themselves from the crowd, rejecting these anthropomorphic notions, and seeking to connect natural phenomena with their physical principles. But long prior to these purer efforts of the understanding the merchant had been abroad, and rendered the philosopher possible; commerce had been developed, wealth amassed, leisure for travel and for speculation secured, while races educated under different conditions, and therefore differently formed and endowed, had been stimulated and sharpened by mutual contact. In those regions where the commercial aristocracy of ancient Greece mingled with its eastern neighbours, the sciences were born, being nurtured and developed by free-thinking and courageous men. The state of things to be displaced may be gathered from a passage of Euripides quoted by Hume. "There is nothing in the world; no glory, no prosperity. The gods toss all into confusion, mix everything with its reverse, that all of us, from our ignorance and uncertainty, may pay them the more worship and reverence." Now, as science demands the radical extirpation of caprice, and the absolute reliance upon law in nature, there grew with the growth of scientific notions a desire and determination to sweep from the field of theory this mob of gods and demons, and to place natural phenomena on a basis more congruent with themselves.

The problem which had been previously approached from above, was now attacked from below; theoretic effort passed from the super- to the sub-sensible. It was felt that to construct the universe in idea it was necessary to have some notion of its constituent parts—of what Lucretius subsequently called the "First Beginnings." Abstracting again from experience, the leaders of scientific speculation reached at length the pregnant doctrine of atoms and molecules, the latest developments of which were set forth with such power and clearness at the last meeting of the British Association. Thought no doubt had long hovered about this doctrine before it attained the precision and completeness which it assumed in the mind of Democritus,* a philosopher who may well for a moment arrest our attention. "Few great men," says Lange, in his excellent "History of Materialism," a work to the spirit and letter of which I am equally indebted, have been so despitefully used by history as Democritus. In the distorted images sent down to us through unscientific traditions there remains of him almost nothing but the name of the "laughing philosopher," while figures of immeasurably smaller significance spread themselves at full length before us. Lange speaks of Bacon's high appreciation of Democritus—for ample illustrations of which I am indebted to my excellent friend Mr. Spedding, the learned editor and

* Born 460 B.C.

biographer of Bacon. It is evident, indeed, that Bacon considered Democritus to be a man of weightier metal than either Plato or Aristotle, though their philosophy "was noised and celebrated in the schools, amid the din and pomp of professors." It was not they, but Genseric and Attila and the barbarians, who destroyed the atomic philosophy. "For at a time when all human learning had suffered shipwreck, these planks of Aristotelian and Platonic philosophy, as being of a lighter and more inflated substance, were preserved and came down to us, while things more solid sank, and almost passed into oblivion."

The principles enunciated by Democritus reveal his uncompromising antagonism to those who deduced the phenomena of nature from the caprices of the gods. They are briefly these:—1. From nothing comes nothing. Nothing that exists can be destroyed. All changes are due to the combination and separation of molecules. 2. Nothing happens by chance. Every occurrence has its cause from which it follows by necessity. 3. The only existing things are the atoms and empty space; all else is mere opinion. 4. The atoms are infinite in number, and infinitely various in form; they strike together, and the lateral motions and whirlings which thus arise are the beginnings of worlds. 5. The varieties of all things depend upon the varieties of their atoms, in number, size, and aggregation. 6. The soul consists of free, smooth, round atoms, like those of fire. These are the most mobile of all. They interpenetrate the whole body, and in their motions the phenomena of life arise. Thus the atoms of Democritus are individually without sensation; they combine in obedience to mechanical laws; and not only organic forms, but the phenomena of sensation and thought are also the result of their combination.

That great enigma, "the exquisite adaptation of one part of an organism to another part, and to the conditions of life," more especially the construction of the human body, Democritus made no attempt to solve. Empedocles, a man of more fiery and poetic nature, introduced the nature of love and hate among the atoms to account for their combination and separation. Noticing this gap in the doctrine of Democritus, he struck in with the penetrating thought, linked, however, with some wild speculation, that it lay in the very nature of those combinations which were suited to their ends (in other words, in harmony with their environment) to maintain themselves, while unfit combinations, having no proper habitat, must rapidly disappear. Thus more than 2,000 years ago the doctrine of the "survival of the fittest," which in our day, not on the basis of vague conjecture, but of positive knowledge, has been raised to such extraordinary significance, had received at all events partial enunciation.*

* Lange, 2nd edit., p. 23.

Epicurus,* said to be the son of a poor schoolmaster at Samos, is the next dominant figure in the history of the atomic philosophy. He mastered the writings of Democritus, heard lectures in Athens, returned to Samos, and subsequently wandered through various countries. He finally returned to Athens, where he bought a garden, and surrounded himself by pupils, in the midst of whom he lived a pure and serene life, and died a peaceful death. His philosophy was almost identical with that of Democritus; but he never quoted either friend or foe. One main object of Epicurus was to free the world from superstition and the fear of death. Death he treated with indifference. It merely robs us of sensation. As long as we are, death is not; and when death is, we are not. Life has no more evil for him who has made up his mind that it is no evil not to live. He adored the gods, but not in the ordinary fashion. The idea of divine power, properly purified, he thought an elevating one. Still he taught, "Not he is godless who rejects the gods of the crowd, but rather he who accepts them." The gods were to him eternal and immortal beings, whose blessedness excluded every thought of care or occupation of any kind. Nature pursues her course in accordance with everlasting laws, the gods never interfering. They haunt

> "The lucid interspace of world and world
> Where never creeps a cloud or moves a wind,
> Nor ever falls the least white star of snow,
> Nor ever lowest roll of thunder moans,
> Nor sound of human sorrow mounts to mar
> Their sacred everlasting calm."†

Lange considers the relation of Epicurus to the gods subjective; the indication probably of an ethical requirement of his own nature. We cannot read history with open eyes, or study human nature to its depths, and fail to discern such a requirement. Man has never been, and he never will be satisfied with the operations and products of the Understanding alone; hence physical science cannot cover all the demands of his nature. But the history of the efforts made to satisfy these demands might be broadly described as a history of errors—the error consisting in ascribing fixity to that which is fluent, which varies as we vary, being gross when we are gross, and becoming as our capacities widen, more abstract and sublime. On one great point the mind of Epicurus was at peace. He neither sought nor expected, here or hereafter, any personal profit from his relation to the gods. And it is assuredly a fact that loftiness and serenity of thought may be promoted by conceptions which involve no idea of profit of this kind. "Did I not believe," said a great man to me once, "that an Intelligence is at the heart of things, my life on earth would be intolerable." The utterer of these words is not, in my opinion, rendered less noble but more noble by the

* Born 342 B.C. † Tennyson's "Lucretius."

fact that it was the need of ethical harmony here, and not the thought of personal profit hereafter, that prompted his observation.

A century and a half after the death of Epicurus, Lucretius* wrote his great poem, "On the Nature of Things," in which he, a Roman, developed with extraordinary ardour the philosophy of his Greek predecessor. He wishes to win over his friend Memmius to the school of Epicurus; and although he has no rewards in a future life to offer, although his object appears to be a purely negative one, he addresses his friend with the heat of an apostle. His object, like that of his great forerunner, is the destruction of superstition; and considering that men trembled before every natural event as a direct monition from the gods, and that everlasting torture was also in prospect, the freedom aimed at by Lucretius might perhaps be deemed a positive good. "This terror," he says, "and darkness of mind must be dispelled, not by the rays of the sun and glittering shafts of day, but by the aspect and the law of nature." He refutes the notion that anything can come out of nothing, or that which is once begotten can be recalled to nothing. The first beginnings, the atoms, are indestructible, and into them all things can be dissolved at last. Bodies are partly atoms, and partly combinations of atoms; but the atoms nothing can quench. They are strong in solid singleness, and by their denser combination, all things can be closely packed and exhibit enduring struggle. He denies that matter is infinitely divisible. We come at length to the atoms, without which, as an imperishable substratum, all order in the generation and development of things would be destroyed.

The mechanical shock of the atoms being in his view the all-sufficient cause of things, he combats the notion that the constitution of nature has been in any way determined by intelligent design. The interaction of the atoms throughout infinite time rendered all manner of combinations possible. Of these the fit ones persisted, while the unfit ones disappeared. Not after sage deliberation did the atoms station themselves in their right places, nor did they bargain what motions they should assume. From all eternity they have been driven together, and after trying motions and unions of every kind, they fell at length into the arrangements out of which this system of things has been formed. His grand conception of the atoms falling silently through immesurable ranges of space and time suggested the nebular hypothesis to Kant, its first propounder. "If you will apprehend and keep in mind these things, nature, free at once, and rid of her haughty lords, is seen to do all things spontaneously by herself, without the meddling of the Gods."†

* Born 99 B C.

† Munroe's translation. In his criticism of this work (Contemporary Review, 1867) Dr. Hayman does not appear to be aware of the really sound and subtle observations on which the reasoning of Lucretius, though erroneous, sometimes rests.

During the centuries between the first of these three philosophers and the last, the human intellect was active in other fields than theirs. The sophists had run through their career. At Athens had appeared the three men, Socrates, Plato, and Aristotle, whose yoke remains to some extent unbroken to the present hour. Within this period also the School of Alexandria was founded, Euclid wrote his "Elements," and he and others made some advance in optics. Archimedes had propounded the theory of the lever and the principles of hydrostatics. Pythagoras had made his experiments on the harmonic intervals, while astronomy was immensely enriched by the discoveries of Hipparchus, who was followed by the historically more celebrated Ptolemy. Anatomy had been made the basis of scientific medicine; and it is said by Draper * that vivisection had began. In fact the science of ancient Greece had already cleared the world of the fantastic images of divinities operating capriciously through natural phenomena. It had shaken itself free from that fruitless scrutiny "by the internal light of the mind alone," which had vainly sought to transcend experience and reach a knowledge of ultimate causes. Instead of accidental observation, it had introduced observation with a purpose; instruments were employed to aid the senses; and scientific method was rendered in a great measure complete by the union of Induction and experiment.

What, then, stopped its victorious advance? Why was the scientific intellect compelled, like an exhausted soil, to lie fallow for nearly two milleniums before it could regather the elements necessary to its fertility and strength? Bacon has already let us know one cause; Whewell ascribes this stationary period to four causes—obscurity of thought, servility, intolerance of disposition, enthusiasm of temper; and he gives a striking example of each.† But these characteristics must have had their causes, which lay in the circumstances of the time. Rome, and the other cities of the empire, had fallen into moral putrefaction. Christianity had appeared, offering the gospel to the poor, and, by moderation if not asceticism of life, practically protesting against the profligacy of the age. The sufferings of the early Christians and the extraordinary exaltation of mind which enabled them to triumph over the diabolical tortures to which they were subjected, ‡ must have left traces not easily effaced. They scorned the earth, in view of that "building of God, that house not made with hands, eternal in the heavens." The Scriptures which ministered to their spiritual needs were also the measure of their science. When, for example, the celebrated question of antipodes came to be discussed, the Bible was with many the ultimate court of appeal. Augustine, who flourished A.D. 400, would not deny the

* "History of the Intellectual Development of Europe," p. 295.
† "History of the Inductive Sciences," vol. 1.
‡ Depicted with terrible vividness in Rénan's "Antichrist."

rotundity of the earth; but he would deny the possible existence of inhabitants at the other side, "because no such race is recorded in Scripture among the decendants of Adam." Archbishop Boniface was shocked at the assumption of a "world of human beings out of the reach of the means of salvation." Thus reined in, Science was not likely to make much progress. Later on the political and theological strife between the Church and civil governments, so powerfully depicted by Draper, must have done much to stifle investigation.

Whewell makes many wise and brave remarks regarding the spirit of the Middle Ages. It was a menial spirit. The seekers after natural knowledge had forsaken that fountain of living waters, the direct appeal to nature by observation and experiment, and had given themselves up to the remanipulation of the notions of their predecessors. It was a time when thought had become abject, and when the acceptance of mere authority led, as it always does in science, to intellectual death. Natural events, instead of being traced to physical, were referred to moral causes; while an exercise of the phantasy, almost as degrading as the spiritualism of the present day, took the place of scientific speculation. Then came the mysticism of the Middle Ages. Magic, Alchemy, the Neo-platonic philosophy, with its visionary though sublime abstractions, which caused men to look with shame upon their own bodies as hindrances to the absorption of the creature in the blessedness of the Creator. Finally came the scholastic philosophy, a fusion, according to Lange, of the least-mature notions of Aristotle with the Christianity of the west. Intellectual immobility was the result. As a traveller without a compass in a fog may wander long, imagining he is making his way, and find himself after hours of toil at his starting-point, so the schoolmen, having tied and untied the same knots and formed and dissipated the same clouds, found themselves at the end of centuries in their old position.

With regard to the influence wielded by Aristotle in the Middle Ages, and which, though to a less extent, he still wields, I would ask permission to make one remark. When the human mind has achieved greatness and given evidence of extraordinary power in any domain, there is a tendency to credit it with similar power in all other domains. Thus theologians have found comfort and assurance in the thought that Newton dealt with the question of revelation, forgetful of the fact that the very devotion of his powers, through all the best years of his life, to a totally different class of ideas, not to speak of any natural disqualification, tended to render him less instead of more competent to deal with theological and historic questions. Goethe, starting from his established greatness as a poet, and indeed from his positive discoveries in natural history, produced a profound impression among the painters of Germany when he published his "Farbenlehre," in which he endeavoured to overthrow Newton's theory of colours. This theory

he deemed so obviously absurd, that he considered its author a charlatan, and attacked him with a corresponding vehemence of language. In the domain of natural history Goethe had really made considerable discoveries; and we have high authority for assuming that, had he devoted himself wholly to that side of science, he might have reached in it an eminence comparable with that which he attained as a poet. In sharpness of observation, in the detection of analogies however apparently remote, in the classification and organisation of facts according to the analogies discerned, Goethe possessed extraordinary powers. These elements of scientific enquiry fall in with the discipline of the poet. But, on the other hand, a mind thus richly endowed in the direction of natural history, may be almost shorn of endowment as regards the more strictly called physical and mechanical sciences. Goethe was in this condition. He could not formulate distinct mechanical reasoning; and in regions where such reasoning reigns supreme he became a mere *ignis fatuus* to those who followed him.

I have sometimes permitted myself to compare Aristotle with Goethe, to credit the Stagirite with an almost superhuman power of amassing and systematising facts, but to consider him fatally defective on that side of the mind in respect to which incompleteness has been just ascribed to Goethe. Whewell refers the errors of Aristotle, not to a neglect of facts, but to "a neglect of the idea appropriate to the facts; the idea of mechanical cause, which is force, and the substitution of vague or inapplicable notions, involving only relations of space or emotions of wonder." This is doubtless true; but the word "neglect" implies mere intellectual misdirection, whereas in Aristotle, as in Goethe, it was not, I believe, misdirection, but sheer natural incapacity which lay at the root of his mistakes. As a physicist, Aristotle displayed what we should consider some of the worst attributes of a modern physical investigator—indistinctness of ideas, confusion of mind, and a confident use of language, which led to the delusive notion that he had really mastered his subject, while he as yet failed to grasp even the elements of it. He put words in the place of things, subject in the place of object. He preached induction without practising it, inverting the true order of inquiry by passing from the general to the particular, instead of from the particular to the general. He made of the universe a closed sphere, in the centre of which he fixed the earth, proving from general principles, to his own satisfaction and to that of the world for near 2,000 years, that no other universe was possible. His notions of motion were entirely unphysical. It was natural or unnatural, better or worse, calm or violent—no real mechanical conception regarding it lying at the bottom of his mind. He affirmed that a vacuum could not exist, and proved that if it did exist motion in it would be impossible. He determined *à priori* how many species of animals must exist, and shows on general principles why

animals must have such and such parts. When an eminent contemporary philosopher, who is far removed from errors of this kind, remembers these abuses of *à priori* method, he will be able to make allowance for the jealousy of physicists as to the acceptance of so-called *à priori* truths. Aristotle's errors of detail were grave and numerous. He affirmed that only in man we had the beating of the heart, that the left side of the body was colder than the right, that men have more teeth than women, and that there is an empty space, not at the front, but at the back of every man's head.

There is one essential quality in physical conceptions which was entirely wanting in those of Aristotle and his followers. I wish it could be expressed by a word untainted by its associations; it signifies a capability of being placed as a coherent picture before the mind. The Germans express the act of picturing by the word *vorstellen*, and the picture they call a *Vorstellung*. We have no word in English which comes nearer to our requirements than imagination, and, taken with its proper limitations, the word answers very well; but, as just intimated, it is tainted by associations, and therefore objectionable to some minds. Compare, with reference to its capacity of mental presentation, the case of the Aristotelian, who refers the ascent of water in a pump to Nature's abhorrence of a vacuum, with that of Pascal when he proposed to solve the question of atmospheric pressure by the ascent of the Puy de Dome. In the one case the terms of the explanation refuse to fall into place as a physical image; in the other the image is distinct, the fall and rise of the barometer being clearly figured as the balancing of two varying and opposing pressures.

During the drought of the Middle Ages in Christendom, the Arabian intellect, as forcibly shown by Draper, was active. With the intrusion of the Moors into Spain, cleanliness, order, learning, and refinement took the place of their opposition. When smitten with disease, the Christian peasant resorted to a shrine, the Moorish one to an instructed physician. The Arabs encouraged translations from the Greek philosophers, but not from the Greek poets. They turned with disgust from the "lewdness of our classical mythology, and denounced as an unpardonable blasphemy all connection between the impure Olympian Jove and the Most High God." Draper traces still further than Whewell the Arab elements in our scientific terms, and points out that the under garment of ladies retains to this hour its Arab name. He gives examples of what Arabian men of science accomplished, dwelling particularly on Alhazen, who was the first to correct the Platonic notion that rays of light are emitted by the eye. He discovered atmospheric refraction, and points out that we see the sun and moon after they have set. He explains the enlargement of the sun and moon, and the shortening of the vertical diameters of both these bodies, when near the

horizon. He is aware that the atmosphere decreases in density with increase of height, and actually fixes its height at 58½ miles. In the Book of the Balance of Wisdom, he sets forth the connection between the weight of the atmosphere and its increasing density. He shows that a body will weigh differently in a rare and dense atmosphere: he considers the force with which plunged bodies rise through heavier media. He understands the doctrine of the centre of gravity, and applies it to the investigation of balances and steelyards. He recognises gravity as a force, though he falls into the error of making it diminish as the distance, and of making it purely terrestrial. He knows the relations between the velocities, spaces, and times of falling bodies, and has distinct ideas of capillary attraction. He improves the hydrometer. The determination of the densities of bodies as given by Alhazen approach very closely to our own. "I join," says Draper, "in the pious prayer of Alhazen, that in the day of judgment the All-Merciful will take pity on the soul of Abur-Raihân, because he was the first of the race of men to construct a table of specific gravities." If all this be historic truth (and I have entire confidence in Dr. Draper), well may he "deplore the systematic manner in which the literature of Europe has contrived to put out of sight our scientific obligations to the Mohammedans."*

(To be continued.)

Correspondence.

† THE REVIVIFICATION OF ANIMAL CHARCOAL.

Whitechapel Engine Works,
London, E.,
August 11th, 1874.

To the Editor of "The Sugar Cane."

Dear Sir,

Numerous articles have appeared from time to time in the pages of your widespread journal, touching but slightly on the merits of the various modes now in operation for revivifying the animal charcoal from the sugar refineries. As it is a subject

* "Intellectual Development of Europe," p. 359.

† See Advertisement in present number.

in which your numerous readers are very much interested, and also ourselves, we are very desirous, with every apology for trespassing on your valuable space, of laying before those particularly interested, our practical experience, which has been of a very extensive nature, in two ways—first, through having probably erected more apparatus for revivifying than any other firm; and secondly, because one of our firm has a large revivifying works of his own, and which, being under our immediate supervision, gives us also the opportunity of more correctly ascertaining the qualities of the sugars made at the refinery for which these works reburn the char.

It is generally understood that there are only two modes of reburning animal charcoal, either by the kiln of vertical pipes of oval or round form, or by the plan of revolving cylinders or retorts, which latter plan has been considerably improved by our numerous inventions, and in which consequently we are very much interested. There is, however, another system in that of beds of ordinary D retorts, a plan which is by no means obsolete, on account of its being adapted to small refineries, where the quantity of char to be reburnt will not warrant the outlay of a kiln or revolver, and which also can be used for making the new charcoal.

The kiln of vertical pipes, the elder of the two plans, on which alone we propose expressing an opinion, possesses many disadvantages in the amount of space it occupies, its cost of erection, and the use of fuel, as compared to the more novel plan of two revolving retorts, one above the other, over one fire. These pecuniary disadvantages or otherwise are not of so much importance as our object to attempt to show which system is the best for the refiner's pecuniary interest in being able to produce a better sample of liquor, and consequently a better quality of sugar.

Revolvers having hitherto received no recognition in your pages, excepting on one or two occasions, as far as our knowledge goes, actuates us to write this article, because in one article, to which we shall presently refer, an objection was made to revolvers on a most erroneous assumption, we think.

In the stationary kiln the revivifying of the char cannot be effective, for the char being dormant in the pipe, that which is nearest to the heated pipe must either be overburnt to allow of the inner or main body of the char being sufficiently burnt, or if the outer is only sufficiently reburnt, the main body cannot be. Then again, the organic impurities being, as it were, smothered, are not free to burn and allow the noxious vapours to escape, which have to percolate upwards through the superincumbent char, and are, we maintain, retained in the char when it issues out again for use in the refinery; the porosity of the grain is thereby clogged with the carbonised residuum, which must necessarily defeat the desired action of the char to present the greatest amount of surface for decolorising the sugar liquors, and hence we ask, Is this plan the best for reburning? We decidedly say, No. But, on the other hand, with revolvers (one over the other), we say the defects above alluded to are remedied, as we shall explain after stating briefly the *modus operandi* of the plan, which no doubt to most of your readers is at present unknown. The charcoal as it comes from the refinery is fed into the top retort, which is the drying cylinder, and is continuously carried along and falls into the bottom one, by which it is reburnt thoroughly, and then discharges into the coolers. We now have to refer to the article before alluded to, which, at page 69 in your number for February, 1873, will be found the following remark :—"The chief objection to this latter class of kiln (the revolving kiln) is that in them the char is kept continually in motion, the grains rubbing against one another as they roll over, and the waste by attrition is consequently very great." As this remark, we fear, has gone far to prejudice a great many from adopting our revolvers, it may appear strange that this assumed objection we heartily accepted as one of its best recommendations, and one of the main benefits over the stationary kiln pipe, inasmuch as by the constant reburning a great evil is effected by the phosphate of lime being gradually fused and a sort of carbonaceous skin formed over the grain, which by the "attrition" is actually broken, and consequently presents again its desired porosity, which is the virtue of the char as a

filtering agent, for by the rolling motion each particle of the char comes in contact with the heated retort, and the organic matters burn freely and the noxious vapours enabled to escape. The loss by dust, which by the way, being so light, escapes with the vapour, is collected in a receiver, and is sold for its value, the loss on which being considerably more than compensated for by the finer samples of liquor, which analyses have at all times shown our reburnt char to give, than from kiln pipe burnt char, and which is testified by the many refiners and others who have the revolvers in use.

To verify our foregoing statements, we may say that at present there have been erected 133 of our apparatus, capable of turning out the aggregate amount of over 10,000 tons per week.

We fear we have trespassed too much on your valuable space to offer further remarks, but it will give us much pleasure if any who are interested in the matter will do us the honour to visit the reburning works which are near here, and where twelve apparatus are erected, capable of reburning over 900 tons per week, most of which are constantly at work reburning for one sugar refinery which has discarded kilns of the old type.

With every apology for this lengthy letter,

We remain, Sir,

Yours obediently,

Brinjes Brothers.

To the Editor of "The Sugar Cane."

Sir,

I had expected, before this, to fulfil my promise of statistics, obtained by my process for clarifying cane-juice. I looked forward with confidence to experiments in the presence of the Honourable William Russell, whose judgment is indisputable, and who deservedly occupies the highest position in the esteem of

the planters, in Demerara, by reason of his superior attainments, experience, &c. The manager of the estate, however, had introduced some charcoal for the first time, as an added filtrant, and, unfortunately, the comminuted particles—unexpected by him—escaped, and impurified the sugar-product.

Mr. Russell, however, took away with him two bottles filled with cane-juice. One of them was filled with juice flowing from the mill, and the other with juice after it had been purified by my process, where the major portion of the impurities are separated at a nominal current cost whilst the juice is still cold; that is, before heat is applied, or fermentation set in, which inextricably mixes the impurities, if present, with the sugar, to boil them together and degrade, or decompose and lose the sugar. He tried the contents of both bottles, in the usual way, by the polariscope, and found them "*exactly alike*" for sugar. The clarified juice had certainly lost impurity, but had not lost one atom of sugar. The juice was thus found to contain 1·63 lb. of sugar in each gallon of cane-juice.

The honourable gentleman also told us, in his published letter, that he had juice of the same quality in his neighbouring estate, where he required 1800 gallons of that juice to make a hogshead containing 1900 lbs. of sugar.

Although more would have been more welcome, yet, I apprehend we have enough here to lead us to something of importance. Thus, we may discover the amount, and the value of the sugar which he *uses*, he *sells*, and he *loses*. The importance of these cannot be over-estimated. He *uses* on his own, sufficient, authority, determined by the polariscope,

1800 (gals. of cane-juice) × 1·63 (lbs. per gal) = 2934 lbs. of sugar *used*.

And 1900 ,, *got* in hhd.

The difference is..... 1034 ,, *lost*.

Now these 1034 lbs. of V.P. sugar represent a money value, say 5 dols. 18 c., or 21s. 7d. per cwt., as in May, 1874, in Demerara, when and where these experiments were made.

Then 1034 lbs. @ 21s. 7d. per cwt.	£9	19	3
But he also got 50 gallons of rum 40 o.p. @ 53c..	5	10	5
Which reduces the *loss per hogshead* to	4	8	10
Possibly he made, at least, 5 hhds. daily.....			5
Then his *daily loss* must have been	£22	4	2
And if he worked 6 days in the week.....			6
His *weekly loss* must have been about	£133	5	0
If we add expenses for manufacturing rum, such as interest on capital, wear and tear, wages, casks, staff, hospital, transit, and incidentals, they cannot be much less than	6	15	0
Which brings the *weekly loss* to.....	£140	0	0

Let us take *the loss on* 20,000 *hhds. of sugar*, aided by sulphurous gas. The total loss=(20,000 × ($\frac{140}{30}$) £4 13s. 4d. (per hhd.) =£93,333 6s. 8d.

There is scarcely a planter who is not conscious of an undetected loss of sugar. The inexperienced pointed at the mill as the source, or cause of this loss, and engineers could discover no value for that opinion, having considerably strengthened the mills, without affording the desired remedy. But we may see clearly now where this serious loss does occur, and that it is independent of the mill. It is the consequence of boiling together the impurities with the sugar. They must therefore be separated, else a large portion of the sugar is degraded by impurity, when aided by fermentation and by heat. These operate separately, and also together, to degrade the sugar to molasses, or decompose it into carbonic acid gas, and some other matters which are worse than worthless, requiring the expensive refiner to separate them. We get a pure sugar only with a pure juice, and in a much larger quantity than common product when purified before heat is applied. Then the loss complained of is considerably reduced, if not positively avoided.—Yours obediently,

W. EATHORNE GILL.

34, *South Hill Park, Hampstead,*
London, N.W.

URBAN CANE MANURE EXPERIMENT IN ANTIGUA.

To the Editor of "The Sugar Cane."

Sir,

Dr. Phipson (p. 417) records the results obtained upon 2¼ acres of canes treated with some special manure. The figures given are totally unintelligible, but I write to inquire whether the estate in question is furnished with a cart weighing machine, or in what manner nearly two hundred tons of canes were weighed with such a degree of accuracy that their aggregate weight is given to single pounds?

If the writer would explain how an experiment similar to this can be conducted with such accuracy on an ordinary West India estate, he will convey valuable information; or can he assure us that the practice of the well known and highly respected owner of North Sound estate adopts the practice of weighing all his cane, in which case he will have furnished an example worthy the imitation of all planters, whatever the merits of the manure may be.

I am, yours truly,

A West Indian Planter.

To the Editor of the "Sugar Cane."

Dear Sir,

If, as Dr. Phipson says in *The Sugar Cane*, 2¼ acres of canes yielded 3 (40 inch) hogsheads and 2 barrels, or say 3 tons of sugar from 194 tons 16 cwts. 0 qrs. 4 lbs. (or 86 tons 11 cwts. 2 qrs. 8 lbs. per acre) of canes, the canes only yielded 1½ per cent. of their weight in sugar, which is absurd for such a yield of canes. If he *meant* to say that 1 acre produced 86 tons. 11 cwts. 2 qrs. 8 lbs. of canes, and that 3 tons of sugar was obtained from this weight of canes, then the canes only yielded 3·97 per cent. of their weight in sugar, an amount it is absurd to congratulate himself on.

Did the writer intend to say that he got 3 tons from 2¼ acres, or 3 tons from 1 acre? And in what way can he make the relation between his weight of canes and weight of sugar, reasonable. It is scarcely possible to discuss his figures until what he intended to say is made clear.

Yours very truly,

Joseph B. Forster.

SUGAR STATISTICS—GREAT BRITAIN.

To August 15th, 1874 and 1873. In Thousands of Tons, to the Nearest Thousand.

	STOCKS.						IMPORTS.						DELIVERIES.					
	London.	Liverpool	Bristol.	Clyde.	Total, 1874.	Total, 1873.	London.	Liverpool	Bristol.	Clyde.	Total, 1874.	Total, 1873.	London.	Liverpool	Bristol.	Clyde.	Total, 1874.	Total, 1873.
*British West India	..	..	..	..	..	70	..	..	..	..	..	137	..	..	..	..	..	105
British East India	..	..	..	..	..	16	..	..	..	..	..	21	..	..	..	..	..	17
Mauritius	..	..	..	..	..	4	..	..	..	..	..	37	..	..	..	..	..	38
Cuba	..	..	..	..	..	32	..	..	..	..	..	66	..	..	..	..	..	51
Porto Rico, &c. ..	..	..	..	..	..	20	..	..	..	..	..	35	..	..	..	..	..	21
Manilla & Java ..	..	..	..	..	..	38	..	..	..	..	..	43	..	..	..	..	..	34
Brazil	..	..	..	..	..	41	..	..	..	..	..	79	..	..	..	..	..	62
Beetroot, &c.	..	..	..	..	..	3	..	..	..	..	..	56	..	..	..	..	..	73
Total, 1874 ..	103	66	10	51	230	224	184	119	56	117	476	474	160	105	53	120	438	401
Total, 1873 ..	87	64	8	65	6 increase		162	122	53	137	2 increase		142	88	50	121	36 increase	

* The particulars of stocks in different kinds of sugar cannot, at present, be given.

STATE AND PROSPECTS OF THE SUGAR MARKET.

The month of August has upon the whole been characterized by a firm market for sugar. A large business has been transacted, and but for the heavy stocks in the country a substantial advance in prices would have seemed inevitable. The equalizing influence of the stock has however so far rendered temporary the higher quotations which have several times during the month been declared, and the net result proves to be that prices are, with little exception, the same as those ruling at the end of July.

The lower grades of sugar have fully maintained their relative superiority—indeed for Jaggery and others of the lowest descriptions very long prices have been paid for future delivery. The market also exhibits a considerable element of speculation, especially in the lower kinds of sugar.

The active movement in the sugar market, coupled with some falling off in the importations, has told upon the stock, which is now some ten thousand tons below last month's, and only two thousand tons in excess of that of 1873, when the average price of British Plantation sugar was 23s. 6d. per cwt., less duty 2s. 5d., say 21s.; the price is now also 21s. per cwt.

The latest quotations of other standard qualities of sugar are as follow:—No. 12 Havanna afloat 24s. 6d. to 25s., showing no difference from last month; fair to good refining Muscovadoes, 22s. to 22s. 6d.—a slight advance; middling to good brown Bahia, 18s. 6d. to 19s. 6d., or an advance of sixpence. The price of common refined lump is now quoted at 29s. 6d. to 30s., against 30s. to 31s. last month.

THE
SUGAR CANE.

No. 63. OCTOBER 1, 1874. Vol. VI.

☞ The writers alone are responsible for their statements.

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THE EUCALYPTUS GLOBULUS, OR TASMANIAN BLUE GUM TREE.

In our last number we presented our readers with the concluding portion of a series of important papers "On the Influence of Forest on Rainfall," which have been written for, and have appeared at intervals in *The Sugar Cane*. We now submit to their notice an account of one particular kind of tree, the cultivation of which in tropical and semi-tropical countries would appear to promise great advantages. Its extraordinarily rapid growth would soon afford the desired covering over bare and arid regions, whilst its property of changing the condition of swamps and destroying noxious miasmata would render many a district habitable which is now productive of little else than deadly fevers. The following circumstantial description of it is extracted from a paper in the July number of *Chambers' Edinburgh Journal*:—

"Some time ago (December 6th, 1873), we had a short article on the *Eucalyptus globulus*, or Tasmanian Blue Gum Tree, and its marvellous properties as regards the drying of marshes and prevention of malarious disease. We ventured to ask for precise and trustworthy information on the subject, and the following has been sent to us by a correspondent, which we submit to our readers:

"'Much interest,' he proceeds, 'has recently been excited among men of science, especially in France, concerning the Tasmanian Blue Gum Tree (*Eucalyptus globulus*), in consequence of the power which it seems to possess of preventing intermittent

fever in the most swampy and malarious districts. There is a large amount of evidence to show that it possesses this power in a high degree, so that not only is intermittent fever unknown where it naturally grows in abundance, although in situations and in a climate where its prevalence might be expected, but places previously most subject to that afflictive malady cease to be so when this tree is planted there. If all this is confirmed, as there is good reason to hope it will, the Tasmanian Blue Gum Tree must be deemed one of the most valuable trees in the world, and to many countries it will prove an inestimable boon.

"'The Gum Trees forming the genus *Eucalyptus* of botanists, which belongs to the great natural order *Myrtaceæ*, are almost exclusively natives of Australia and Tasmania. A few species are found further north in the islands of the Malayan Archipelago, and in the Eastern Peninsula. Although ranked in a natural order of which the Myrtle is the type, they are very unlike Myrtles in their general appearance, and constitute a characteristic and most peculiar feature of Australian vegetation. Scattered over the face of the country, as the trees of Australia generally are, growing singly or in clumps, like trees in a lawn, instead of being congregated in thick forests, like the trees of most other parts of the world, they differ from other trees by a remarkable peculiarity of foliage. The leaves have not one face turned to the sun and the other to the earth, as trees and plants of all kinds generally have, but they stand with their edges upwards and downwards, so that each surface is equally presented to the sun. There are some species in which this is not the case, but they are only a few among the numerous species of the genus. The leaves of all the Gum Trees are leathery, and undivided, and abound in a volatile oil, which has an aromatic and not unpleasant odour. Many of the species abound in resinous secretions, from which they receive the name of Gum Trees. Some of them attain a great size, with trunks 16 feet in diameter. They are remarkable for their very rapid growth, and are easily felled, split, and sawn; the timber, when green, being very soft, although it becomes very hard after exposure to the air, and is then useful for many purposes, amongst

which is that of ship-building. The *Iron Bark Tree* and the *Stringy Bark Tree* of Australia are among the species of this genus most important for their uses as timber trees. *Botany Bay Kino* is a resinous secretion of another species, of some value in medicine.

"'The Tasmanian Blue Gum Tree grows plentifully in the valleys, and on the lower mountain slopes of Tasmania. It attains a height of 200 feet, and sometimes more, and a diameter of stem at the base of 11 to 22 feet. The stem is naked as a granite column almost to the top, where it sends out branches forming a small crown, with thin foliage. The leaves are lanceolate, or ovato-lanceolate, generally twisted, and of a dark bluish green colour, with a camphor-like odour. The timber has an aromatic odour, and is scarcely liable to rot, however long exposed to the action of water. It is therefore much used for ship-building, for piers, and for a great variety of other purposes, and is a considerable article of export from Tasmania.

"'Various medicinal uses have been ascribed to the leaves of this tree, a preparation of which has been represented as even more efficacious than quinine in the cure of intermittent fever. But this and other alleged medicinal properties require further investigation.

"'There seems, however, to be good reason for believing that this tree acts as a preventive of the miasmata which produce fever and ague. That Tasmania is free from this malady, or nearly so, whilst in almost all other countries of similar climate it is sadly prevalent, is of itself a significant circumstance; but it could not be inferred from this alone that this particular tree is the cause of its immunity. However, a number of considerations having led to the opinion that this is probably the case, the tree has been introduced elsewhere, and the experiment tried in circumstances in which the result must be regarded as affording very conclusive evidence. Some unhealthy localities at the Cape of Good Hope were rendered perfectly salubrious, apparently through the influence of the Blue Gum Tree, within a few years after the plantations of it had been made. It was then tried in Algeria, and on a pretty large scale, in different parts of the country; and

places that had previously been almost uninhabitable in the fever season became at once exempt from all such disease, even in the first year of the growth of the trees. The colonists and their families now enjoy excellent health, where the climate for several months in the year used to be absolutely pestilential. Similar results have followed the introduction of this tree in Cuba and in Mexico. Even in the South of France it has been productive of the most beneficial effects. A station house at the end of a railway viaduct in the Department of the Var was so unhealthy, that the officials had to be changed every year; but forty of these trees having been planted, its unhealthiness entirely ceased.

" 'There is hope, therefore, for the Campagna di Roma, that its cultivation may yet be carried on with the greatest facility and advantage, and the natural fertility of its soil turned to the utmost account. But if so, there is hope also of speedy immunity from sore distress for the inhabitants of many parts of the world where intermittent fevers prevail at certain seasons of the year. How happy would many North American farmers be, if by planting a few hundreds of Blue Gum Trees, they could secure probable exemption from this disease for themselves and their families. The range within which this tree can be made available must, however, be limited by climate. It does not bear the winter even in the South of England, except when the season is unusually mild; and a great part of North America, where intermittent fever is very prevalent every year during the summer months in all low grounds, and on the slopes adjacent to them, is subject to a severity of cold in winter which would certainly destroy every plant of this species. But in the Gulf States of North America, and to some extent northwards, in the valleys of the Mississippi and other rivers, and along the Coast of Florida, Georgia, and Carolina, its introduction may probably be found in the highest degree beneficial, as also in the West Indian islands and tropical parts of America. It may, perhaps, be doubted if the climate of the West Coast of Africa would not prove too warm for it, although its successful introduction in Cuba seems to prove that it is capable of enduring the heat of the tropics; and as the fevers of that region

constitute the chief difficulty in the way of European colonisation there, the acquirement of the means of preventing them would open up prospects entirely new. It will probably not be long till the powers of the tree are fully tested in India, and if they are found to be as great as French naturalists seem at present to believe, its introduction will probably hasten the cultivation of many a jungle, besides preserving the health and saving the life of many a civilian and many a soldier. One great tract in the north of India seems especially to demand its introduction, and to be, in climate, perfectly adapted to it—the *Terai*—which stretches along the whole base of the Himalaya, where they slope down to the plains, a tract in many parts extremely beautiful, finely undulating, and rich both in grass and trees, but exceptionally dangerous from the miasmata which it exhales, for which science has not yet been able well to account.

"'The Blue Gum Tree has been supposed to exert its influence by the aromatic odour which it diffuses in the atmosphere. But there seems to be much reason for thinking that the secret of its power lies, in part, at least, in the extreme rapidity of its growth, requiring an extraordinary consumption of water, so that it thoroughly drains the soil around it. A marsh near Constantia, in Algeria, was found to be completely dried in a very short time by a plantation of Gum Trees. Such is the rapidity of growth of the tree, that seedlings raised in a hotbed, and planted out in the open air in the South of England, have been known to attain a height of ten feet in the same year. In a warmer climate the growth is probably still more rapid; but we know of no other instance of such rapidity in the case of any valuable timber tree of the temperate parts of the world.'"

In addition to the above we give the following, which appeared in the *Pall Mall Gazette*, (London,) some time ago:—

"A correspondent writes to us: 'The Eucalyptus, a tree of the myrtle family, was introduced from Australia into Algeria, about eleven years ago, and flourished surprisingly. It was not, however, until the last seven years that any extensive plantations were made. A few days since, we made an excursion to visit

those on the estates of M. Trottier, M. Ramel, and M. Cordier. The seeds from which these trees were grown were mostly sent by Mr. Edward Wilson, whose persistent generosity in aid of all efforts for acclimatisation cannot be too gratefully acknowledged.

"On M. Trottier's estate, at Hussem Dey, we walked under tall trees, the *Eucalyptus globulus*, (blue gum trees,) on an average fifty feet high, which seven years ago were seed; this particular plantation was on bad soil, and had not had very experienced care, yet the growth of the trees was marvellous. In this evergreen wood all around us were tall reddish smooth stems with the bark hanging down in a ragged untidy manner, for the tree sheds its bark in winter, and grey willow-like leaves were waving on flexible boughs. For about 25 feet the stems of the trees in the inner part of the plantation rose up with no branches at all, but on the skirts of the wood the trees sent out branches, in the light and air, nearly to the ground. It produced a curious impression to walk in the dim twilight of this Australian-African forest, and to think that this was also a wood of the Miocene period. Beautiful is not the word I should apply to its appearance, but in exchange for bare sun-baked earth, or deadly swamps, I must say these Eucalyptus forests are most grateful, and the smell delightfully resinous, warm, and gummy. The multitude of birds in the branches and their busy twitterings added much to the pleasant impression. I measured these trees as I walked along, and found them from 40 to 45 inches in circumference, those on the borders of the wood, of course, always a few inches larger. M. Trottier thinks the red gum, Eucalyptus resiniferous, which is not yet planted in any great numbers, will be the most hardy tree, and consequently best suited to the neighbourhood of Algiers. One red gum which I measured was 31 inches in circumference, and its age just six years, having been sown in February, 1868. This tree was in the perfection of health, and the same may be said of all the Eucalyptus trees in the plain.

"All the large plantations in Algeria are the *Eucalyptus globulus*, but, as time goes on, varieties are being tried. On M. Cordier's magnificently wooded farm, in the dismal region of the

Maison Carrée, we saw a hundred different trees of Eucalyptus. We were accompanied by some gentlemen, who were principal authorities on trees in this colony, and they seemed to expect much from the *Eucalyptus Colosea*, which is a hardier tree in the sun than the Globulus, and is already growing in the desert at Lagouat. M. Cordier showed us one *Eucalyptus Globulus* which was eleven years old, and measured 81 inches in circumference, and he told me of some at Bonfarik, in the plain, which were some inches larger and not so old. There seemed to be a general impression that the Eucalyptus was a fever destroying tree, and of the greatest importance to the colony from that point of view; but as general culture goes on, as well as plantations, the sanitary improvement in the plain ought not all to be set down as certainly due to the *Eucalyptus Globulus*. The aromatic odours of these gum tree plantations in the dismal part of the plain, at the mouth of the fever breeding river Harach, instead of the malaria vapours, is certainly an incalculable benefit; but I will not assert positively that the fever is destroyed. If the growing forests are judiciously managed, they must be a source, in fourteen or fifteen years, of great profit, as wood is very dear here, and the Eucalyptus is a fine, hard wood, and makes excellent sleepers for railways, and is useful in all places where a sound wood that will stand damp is required. We walked in the four year old plantation at the Maison Carrée, where are 20,000 gum trees on 90 acres of unhealthy soil. These trees are now from 14 to 20 feet high and look as if they would grow to large forest trees, after their fashion, in about six years more.

"Many village communities in the plain have planted scores of gum trees in this neighbourhood, and feel the benefit, but at present there is certainly an exaggerated manner of speaking of the Eucalyptus. It is praised as a scent, as cigars, as a medicine, as a tonic, as a throat lozenge, and above all as a bath. Branches and leaves are put into hot water, and I am assured, by those who have tried it, that such baths remove rheumatic pains, neuralgia, and the debility left by the malaria incidental to the country. Finally, our opinion is that the Eucalyptus tree may prove the

most powerful element of civilisation as yet put in force on the coast of North Africa; that in a few years it will be self sowing, and thus take its place as a naturalised subject, there is very little reason to doubt. At Cannes, on Lord Brougham's grounds, the young trees come up from the seed of the old ones under the branches, and in a few years we may confidently expect the same process to take place in Algeria. This year the seed ripens plentifully on the seven year old trees. Thus in a few years we may see one thing most longed for on the Barbary coast, that is shade from the fierce sun. We may also have a most profitable crop, and the healthy influence of these resinous-scented gum trees as a counter-action against malaria. The Eucalyptus tribe seems to meet not only the requirements of health, comfort, and pleasure, but of commerce and general prosperity.

The thinnings of gum tree plantations, if closely planted, might also prove of immense advantage as fuel, where this is scarce, in the manufacture of sugar and other products of countries suited to its growth.—*Ed.*

ON THE TREATMENT OF UNCRYSTALLIZABLE SYRUPS OF BEET SUGAR WITH PHOSPHORIC ACID.

From a lengthened series of laboratory experiments on the syrups obtained from the juice of the beet, I have been induced to modify received opinions as to the cause of the production of uncrystallizable syrups, more particularly that part of the formulæ of the books which treat the salts of lime as of minor importance in the syrup, as compared with the salts of potash and soda.

I have long been convinced that some error existed on this point, and my researches have been more particularly directed towards clearing up all doubts on the subject of the lime.

In order to ascertain whether the carbonic acid, as ordinarily used, throws down *all* the lime, I urged that treatment on until an acid reaction appeared on the test paper, and if (as has been supposed,)

the effects of the gas carbonated *all* the lime, the whole of that substance ought to be thrown down, or at all events rendered so insoluble that it could be taken out with a good filter.

Accident however proved to me that this was by no means the case, and that under particular circumstances, large deposits of lime could be produced from syrups, *after* all trace of that substance by the various test papers used to discover it, had failed in showing its presence.

This could only happen from one of two circumstances, either, there were kinds of lime which were not affected by carbonic acid as ordinarily used, or received notions on the subject of lime in beet juice are erroneous.

The lime I used, was made from stratified limestone of a blue colour, and for ordinary purposes apparently very pure and strong.

On close enquiry I found that the strata of limestone varied considerably in quality, and that some of the strata although intermixed with the ordinary limestone, and immediately adjoining it, would produce "water lime," while other kinds would produce only the ordinary fat lime as used for plastering purposes. This fact showed at once that the lime remaining in the syrup unaffected by the carbonic acid *might* be the water lime, or some other kind of lime, which remained soluble in the syrup, and which resisted the action of the carbonic acid, and prevented crystallization, and therefore if I attempted to destroy its solubility I must resort to some other agent instead of the carbonic acid. The only other agent which could be economically used was "phosphoric acid." We have in Canada large deposits of phosphate of lime, which can be had at little cost, beyond that of mining it, and to that agent my attention was naturally directed.

I therefore obtained some of our ordinary mineral phosphate (apatite), and having powdered it, and mixed it with a due proportion of sulphuric acid and water, and thus at once reduced the phosphate to a sulphate, leaving the phosphoric acid in the supernatant liquor. I was quite aware that this liquid still contained a portion of lime, but the phosphoric acid so far predominated as to insure for me a considerable demand for lime, when the liquid came to be used where lime was.

This "acid phosphate" I mixed with the syrups until they showed a full acid reaction with the "*papier de tournsol,*" and I then boiled the whole.

The consequence was a great deposit of lime and a considerable decolorization of the syrup, and on filtering and again boiling down to crystallization point, after a few days' rest in the hot closet, a large cup of crystals was formed without the aid of bone black in any way. Having had such success with ordinary syrup, I next turned my attention to other samples, from some of which the first crop of crystals had been taken, and others which, although they had been made for some years, would not crystallize at all, the consequence has been in every case a considerable deposit of lime, and a large amount of crystallization. The samples, which had not been submitted to the bone black, crystallized quite as well as those which had been treated with that substance, and indeed in some cases better.

I think I may now therefore seriously recommend this cheap and efficient agent to the use of manufacturers of beet sugar on a large scale in Europe,—I have no doubt that eventually the "acid phosphate" will be found the cheapest means of eliminating lime from beet juice, even without the use of carbonic acid, but I cannot doubt the usefulness of the plan, when combined with the use of the carbonic acid, in the treatment of all syrups about which there arises any difficulty in crystallization.

After some months of trial in these experiments, I met with a full confirmation of my ideas by the experience of Dr. Scheibler, who it appears had been led to the same course, and with similar results, the only difference being that Dr. Scheibler used the phosphoric acid obtained from the bone ash, whereas I had used the far cheaper article of the natural mineral phosphate, ("apatite.") I was very much pleased with this fact, for although I imagined the European experiments deprived me of all prospect of profit from the discovery, yet the fact that my ideas were verified by the researches of so great a chemical authority as Dr. Scheibler, was in itself extremely gratifying.

The bone black treatment of crude beet sugar is so extremely

difficult, expensive, and troublesome, that it is the turning point in the manufacture.

If we can succeed in obtaining good, strong crystals of sugar from the juice of the beet, without the use of the bone black, it sweeps a whole heap of difficulties out of the way, and will enable us to provide for the refiners an article at a cheap rate, and with a good profit, without trenching on the refining processes of the regular sugar refiners.

I have very little doubt that large quantities of both potash and soda are eliminated by this treatment with phosphoric acid, although I have not yet proved that fact,—but I have proved incontestably (and any person can prove the same by following the same course), that *something* is removed by this process, which is a great hindrance to crystallization.

The foregoing naturally leads to a further enquiry, viz :—Are we not deceiving ourselves with respect to the "salines," in the same way in which we have been deceiving ourselves with respect to the lime?

The potash of the laboratory is "calcined potash," which has been reduced from its elements by the aid of fire, and it is the result of a destructive distillation, in which all organic substances are either consumed or driven off, while the potash remains indestructible, and it is on *this* substance that all our ideas are founded.

The potash and other salines in the beet, are the results of natural growth, taken up from the earth, or by the effect of the spores and spongioles of the roots, formed by the joint effects of the soil and the sap of the plant. Can we say for certain that these saline substances, when they are formed in the root of the plant, partake of the nature of "calcined potash," or are they not affected, and possibly removable, by a different process than is used to determine the existence or removal of "calcined potash?"

It is quite true that calcined potash and soda can be obtained in large quantities from the ashes of the beet, but in the root *they have not been calcined*, and may be subject to far different laws to those which govern the calcined salines.

In clearing up new forest land we find that the ash-heaps

(which contained so much calcined potash,) during the first year of cropping, affect vegetation most powerfully, by an apparent over fertility, or at all events an unequal or over growth, so much so that, although the ash-heaps are carefully spread, yet in the place where they were, wheat and other grains will scarcely come to perfection as seed bearing plants,—the second year of cropping this effect is scarcely seen, and after the second year no effect whatever is produced on the crop. Where is the potash gone to? No doubt large portions of it are dissolved and run off with the surface water,—other portions leach out and pass into the subsoil, but by far the larger portion must be absolutely absorbed by the soil, and, in the process of absorption, becomes so far modified in its nature, that it produces no visible effect upon vegetation,—and vegetation is the most skilful and elaborate analyst that we are acquainted with.

All the cereals, and the sugar-cane, produce from the soil large quantities of the silicates, these form the strength, and, so to speak, the "bones" of the stem; the plant has taken them up from the soil, and they are spread on the surface of the skin or rind of the stem,—but these silicates are most certainly not the effect of any of the violent processes by which we obtain ordinary silicates, nor are they to be expected to be subject to the same laws which govern the chemical silicates, notwithstanding that when burned they will produce chemical silicates.

This subject might be much further pursued, but the foregoing is as much as I dare trespass on your room.

Edwd. L. Cull.

Toronto, Canada, 22nd June, 1874.

ESTIMATION OF POTASH IN SYRUPS.

By R. Frazer Smith, F.C.S.

It may possibly be of use to some of the readers of *The Sugar Cane*:—The description of an easy and practical method for the estimation of potash in syrups and sugars. It is assumed as a general rule that two-fifths of the weight of ash is potash, and in

the majority of instances this assumption is a correct one. For practical people with little time at disposal, a knowledge of the percentage of potash in syrup or sugar is all that is wanted, so far as the extraction of the salts from these bodies is concerned, and an expeditious and correct method like the following may occasionally save an estimation of the total ash :—

Weigh 100 grammes of syrup in a beaker, add 30 c.c. alcohol and 30 c.c. water, containing in solution about 15 grammes tartaric acid. Stir vigorously for a few minutes, then allow the mixture to rest for about half an hour. Collect the precipitate upon a tared filter, allow it to drain, then wash with other 60 c.c. mixed alcohol and water. Dry in a water bath and weigh. One-fourth of the precipitate is potash. In the event of any doubt being entertained of the purity of the collected bitartrate, weigh 5 grammes, and incinerate in a platinum capsule. Boil the resulting black mass with water, filter and wash the carbon thoroughly with hot water until alkalinity ceases. Titrate the solution in the ordinary manner with normal acid, and calculate the potash in the original substance. However, as a rule, the precipitate is pure cream of tartar, and the incineration is only necessary when much lime is present in the syrup.

The following are estimations made by this method, as compared with the ash. The syrups are all procured from foreign sources :—

Ash.	Potash calculated as Two-fifths of Ash.	Potash by Tartaric Acid method.
5·16	2·06	1·94
5·44	2·17	1·83
6·33	2·53	2·43
7·63	3·05	3·61
8·26	3·30	3·62
8·19	3·27	3·69
6·83	2·73	2·74
6·17	2·46	2·23
7·12	2·85	2·97
4·7	1·88	1·81

Greenock, 15th August, 1874.

THE PROFITABLE MANUFACTURE OF SUGAR FROM THE SUGAR-CANE.

By W. Eathorne Gill.

Its fiscal freedom induces increased consumption of sugar, and the natural effect of increased demand is an increased benefit to the producer. Sugar is produced in our colonies from the sugar-cane, and on the continent, by foreigners, from the beet-root. We sometimes find antagonism in competition where there is no sympathy. The competition of Frenchmen has been fostered by their Government, who give the beet-sugar-makers a profit, in the shape of a bounty on all the sugar they export. As a consequence, we buy French beet-sugar in London cheaper than in Paris. This low-priced beet-sugar compels the English refiner to transfer the pressure to the colonial planter of sugar-canes, or be under-sold by the competing beet-sugar.

Sugar is undoubtedly an important article of commerce. It is second only to corn. Millions sterling are invested in its production, and thousands of tons of our mercantile marine are profitably employed in the transit of sugar from, and of merchandise to, the plantations. Commercial men too—small and great—profit by distributing sugar among the consumers in every family at home. Hence the wide-spread commercial importance of sugar.

At present, the profit of sugar may be said to accumulate in the pocket of the foreigner. He has been guided to success by the first chemical skill of France, Germany, &c. Nor has he hesitated to consult his best mechanics for requisite appliances. To all appearances, he has exhausted these resources. In the words of M. E. Souqes, who discarded the idea of "applying in critical circumstances to the administration that can do nothing," he added, "If the cultivation of the cane suffers from the low prices of sugar, its competitors, the beet-root-growers, are, perhaps, in a still more disastrous condition." This, of itself, is but cold comfort, yet it reveals a fact, which suggests an effort by

cane-planters, the success of which may determine the now quivering balance to incline in their favour, and afford them such a margin of profit as can defy their competitors. This is practicable, whenever held to be desirable.

The cane-grower has a margin in unintentional reserve. He would willingly utilise it, but, hitherto, success has eluded his every effort to grasp it. In evidence of this, we see the Chamber of Agriculture of La Poit-a-Pitre (Guadeloupe) is now offering "a premium of 100,000 francs to the discoverer of an economical process." They may safely double their offer, handsome as it is, for it will never be claimed. They presume to put a bridle on genius, and in their wisdom dictate the course to be pursued, when success lays in the opposite direction. *They want more sugar*, granted; but they also require more cane-juice for their prize, whilst they know not how to advantage themselves of all the sugar they already have under control in the cane-juice. They want 80 per cent. of juice from the cane to do this; they must also reduce the ligneous portion of the cane to something like tinder, in one and the same operation; a sheer, practical, impossibility.

But these are not the only planters who are impressed with some undefined idea, that much sugar is lost in their best attempt to save it. These evidently think that the megass contains it, whereas it is the impurities which contaminate, degrade, and lose it for them, when those impurities are fermented and boiled in the juice, Thus planters lose nearly as much sugar as they sell, other some lose much more than they sell, a fact too offensive to be the burden of a song. The practical planter has, before now, promptly disposed of this fact, by pooh-poohing it as a "mere theory," when he assured us that the boiling-house is not his bed-room; he certainly is there frequently, but not to *sleep* there. He did not allow one ounce of sugar to be taken away surreptitiously. Is it *possible*, then, for him to lose tons of sugar every season, and he not know it? Such an assertion is an insult, as much to his integrity as to his understanding, deserving his ineffable contempt; and he indulges it accordingly. In a word, he confidently denounces the idea as simply impossible.

In *The Sugar-Cane* for September, we may read the figures made by a gentleman who is admitted to be the first among the educated practicals of Demerara, who publicly recorded the fact that the cane-juice of a certain plantation contained 1·63lb. of sugar in each gallon. He used 1800 gallons of that juice for each hogshead, containing 1900 lbs. of sugar. We see there must have been 2934 lbs. of sugar in those 1800 gallons of cane-juice, and of these 2934 lbs. he got only 1900 lbs., and lost the remainder of the sugar, which was no less than 1034 lbs.

We may fairly infer that all this occurs daily under first class supervision, aided by the vacuum-pan, and by sulphurous gas, as in the case alluded to. The current value of the lost 1034 lbs. of sugar must have been £9 19s. 3d., minus the *profit* on 40 gallons of rum.

I took occasion to point out how that loss occurs, and how to avoid the loss, in the same number of *The Sugar Cane*. I may add here that I filter the juice, whilst *cold*, through sand, after coagulating the albumen, albumenoids, &c., &c., by self-engendered galvanism, whilst preventing fermentation. All that remains now to be done to the juice, is to evaporate it by a gentle heat, which is in direct contrast to the violent ebullition, which so unmercifully degrades the sugar on many plantations.

My process involves a mere nominal expense, which falls into insignificance in presence of the greater value—now a respectable profit—of the *increased sugar product*, of superior, because purer quality. "The crystals are large, hard, and devoid of molasses." *No chemicals are used to be dissolved in the juice.* In point of fact *the best products were made without lime.* The increased products ranged from 25 to 50 per cent., *according to the temperature at which the juice was evaporated.* The filter differs from other filters, and does not, *cannot, choke.* Letters now before me tell of "the cold cane-juice passing through the separator quite "nicely, throwing up quantities of thick scum, allowing us to drain off after filtration every drop of liquor to the copper wall. The clarification of the cane-juice is quite perfect. I feel confident that immense results will be obtained from your process; in no manner or degree do I

attach the slightest doubt to the working of your process. The liquor is of a fine bright colour, and there was a very marked difference in the time it took to boil off the liquor compared with what is usual," &c.

As advised, I should be doing an injustice to those who are interested in the economic production of sugar, were I to withhold any longer those important facts, which can contribute so much to their advantage.

The question occurs occasionally, "Is not your process as open to beet, as to cane?" Granted; yet not likely to be adopted by beet: and even if adopted, beet has not such a reserve as cane has—a reserve which would still afford the latter a considerable, superior advantage. Beet cannot double its product; we see sugar-cane can do so, very nearly. I had hoped to afford a practical evidence of this fact, and could only approach it as the temperature permitted. To this end I have been struggling with adversity these two years. Repeated breaking of the machinery at the mill, and even an extensive conflagration were among my impedimenta; so also the PERFECT FREEDOM OF MY FILTER FROM CHOKING all this time has been among my very important practical successes.

34, *South Hill Park,*
Hampstead, London.

"IMFEE," "PLANTER'S FRIEND", OR "SORGHUM."

TO THE EDITOR OF THE "NATAL MERCURY."

Aangelegen, near Greytown,
July 1st, 1874.

SIR,

The following will have interest for many of your readers.

I sowed in November and December last 20 acres of land with Imfee; as soon as it was out of ground a heavy hailstorm destroyed the greater part, washing bare places of nearly an acre in many places, and much of the crop; you could scarcely jump from one cane to another. I reckon that three acres successfully

grown would give the same weight of cane that I ultimately got off the twenty.

In April I crushed some of it, and the juice stood at from 8 per cent. to 10 per cent. The cane was in the milky stage.

Now in May I have crushed the whole crop. The juice in every trial carefully made has stood at 10 per cent. I weighed 1000 lbs. of cane, and got from it 48 gallons of juice, or 50 per cent. The brasses of the mill could not be brought up as they should have been, and there was quite another 10 per cent. of juice left in the cane that ought to have been got out, which would have made 60 per cent.

The cane was now mature and the seed beyond the milky stage, although not quite hard, and this would appear to be the proper stage at which to take it, but further experience would be necessary to state positively on this most important point. From the whole crop (say three acres) I have obtained 380 gallons of syrup at an average density of 40 per cent.

Having a market for the syrup, and not having appliances or sufficient experience to granulate it, I have left it at that stage, but a coast sugar-growing friend, who was staying a few days with me, got a sample of large-grained bright sugar from a small quantity of syrup that he granulated wetzel fashion. I have since had a considerable quantity that I put by for a week completely granulated, and am quite satisfied that with either wetzel or vacuum pan and centrifugal it will give as much sugar to the weight of cane as China cane grown on the coast.

I do not know if the same weight of Imfee cane, as of sugar cane, can be grown to the acre. I am inclined to think not, but with cane 1 inch to 1½ inches in diameter and 10 feet high, which much of it was, the weight of a successful crop would be very great.

Those interested can best form their own conclusion as to the comparative value of the Imfee and sugar cane as a crop; but they should bear in mind that the Imfee must have a warm soil and high cultivation, neglect of either particular would be fatal. It will not stand the neglect that the Coast cane crops have

necessarily been subject to, or the careless cultivation generally given to Midland mealies.

My own opinion is, that where sugar cane thrives it is an easier grown crop, but the Imfee would be in many cases a valuable adjunct, and some coast planters of experience attach great importance to it.

At any rate the subject is of sufficient importance to be generally known, and I shall be happy to receive, or impart any information upon it.

I hope to continue and extend the cultivation of it next season.

Yours truly,

H. J. Leuchars.

NATAL.

The abolition of the Sugar Duties may be a matter of less importance to Natal, comparatively, than to other sugar growing colonies of greater age and productive capacity, but it is, nevertheless, an event of sufficient significance to call for more than a passing reference. To us the change comes at an opportune time. Owing to the want of labour, enterprise has been slack, and few estates have been created for same time past. Now, however, that coolies are coming in again, and that railways are in prospect, there is a manifest disposition, on the part of beginners, to commence operations; and on the part of old planters, to improve their mills. The colonies which will benefit most by the removal of these charges are Demerara and Mauritius. The export from these two places cannot be far short of a quarter of a million tons, the bulk of which will now be converted into high class sugars. Here the vacuum pan has only been employed by a few. We cannot reckon up more than ten that are now in operation. The demand among the Boers until lately was for a coarse dark sugar, but we believe with increased wealth has come an improved taste, and we dare say that large fine crystallised sugars will soon be as much in vogue amongst the well to-do farmers of the interior, as the brown treacle

stuff of the past used to be. In the Cape, of course, Natal will always have to vie with the Mauritius. There the preference has mostly been for a sweet, clean, straw-coloured sugar, but that too will doubtless be modified by the production of a whiter grain. The grand point has been reached of equality in the home markets with the products of home or continental refineries. While the differential duties lasted no such equality could be said to exist. The sugars henceforward that will sell best at home will be, either concrete, or an analogous sugar, containing the maximum amount of saccharine in the crudest form, for manufacture by the refiner, or a high class vacuum pan sugar fit for immediate use in British households.

With labour at nominal rates—that is Indians, at 14/- and Kafirs at from 10/- to 12/- per month—Natal ought ere long to produce 100,000 tons of sugar annually. The extended adoption of the central principle will throw the pursuit open to a far larger class of growers. That principle is really co-operation. In Louisiana, sugar planting is finding its true solution in the principle of mutual action. Although most of the mills in that State have been closed, and their owners ruined by the abolition of slavery, some of the wiser and more sagacious employers are finding their compensations in a system of co-partnership between coloured cultivators and themselves as mill owners. Some very suggestive remarks by an able writer in *Scribner's Monthly* (Mr. E. King) are well worth reading on this point.

Is Natal ripe for any repetition of this policy as regards the natives? The history of the Umvoti Sugar Mill would seem to say she is not. From all we can learn regarding that costly experiment in industrial civilisation, its vicissitudes go to show that the mill ought to be held quite apart from the natives. The latter ought to have no voice in its management. On the other hand the fear arises that no body of native cultivators could yet be trusted to keep such a mill regularly and steadily supplied with cane year by year. For the present, therefore, we are inclined to think that we must look to European planters, employing coloured labourers, for the maintenance of Central Mills. That these will arise we

have very little doubt now that coolie immigration is re-established, and if successful we may yet see these beautiful coastlands the scene, as they ought to be, of thousands of thriving plantations where men of our own colour and faith have formed homes to live and die in. There is nothing extravagant in such an expectation if the permanency of labour supplied is assured.

Durban.—The sugar-crushing season, properly so called, not fairly commencing for a month yet, supplies are only from hand to mouth. Orders from the sister colony two months old are not yet fully executed. The late competition for prizes proved what Natal was capable of, some splendid samples being shown. The first prize was carried off by Redcliffe, Clare being second. A considerable sum has been subscribed for prizes to be awarded next November. The renewed certainty as regards labor, puts new life into the planting interests, and, cattle permitting, prospects for next crop are most promising; coolies arriving in large numbers.

We average quotations as under:—

White Crystals (vacuum pan),	1st quality	31/6 at 32/6	per cwt.
White Crystals, ditto	2nd quality	30/6 at 31/6	,,
White Crystals, ditto	3rd quality	30/-	,,
White Crystals (wetzel pan)		28/- to 30/-	,,
Light yellow Crystals		26/- to 28/-	,,
Light yellow counters		25/- to 26/6	,,
Yellow ordinary		23/- to 24/6	,,
Grey, dry and grainy		20/- to 24/-	,,
Syrups		18/6 to 20/-	,,
Ditto dark yellow, and brown		16/6 to 18/6	,,
Ditto low brown		15/- to 17/6	,,

Freight to London, 10/- per ton.

From Natal Mercury, June 18th, 1874.

The following receipt is found very efficacious in ensnaring rats on sugar plantations, where they are often very destructive:—

Powdered Assafœtida.... 2 grns.	Oil of Rhodium..3 drachms.
Essence of Oil of Lavender 1 scrup.	Aniseed 1 drachm.

Mix Assafœtida with Aniseed, then add Oil of Rhodium and stir, after add Lavender, bottle and cork close.

Touch the pieces of poisoned food or trap, lightly, with a feather dipped in the above, carefully avoiding contact with the hand.

STEAM AND ITS USES ON PLANTATIONS.

(From the *Louisiana Sugar Bowl.*)

"Improvements in agricultural operations must keep pace with the progress of other vocations, such as manufactures, commerce and the professions. Nothing should be left undone which we can fairly effect, to increase the yield, cheapen the cost and lighten the labour of obtaining the productions of the earth; we cannot render too cheap or too plentiful the necessaries of life; while, at the same time, the operations of their production should be made as attractive and respectable as possible, that intelligent minds may find as much inducement to engage in this as in any of the other pursuits of civilized life. Mind must be permitted more and more to predominate over muscular labour, and, as far as may be, machinery must take the place of animal forces in farm operations as in other pursuits of civilization."

The great importance of steam culture being admitted, on examination of the numerous plans, cuts and descriptions of traction engines, found in patent office reports, etc., for traversing the field, in attempts to plough with steam, it was noticed that with a single exception common ploughs were used. This induced the opinion that such ploughs were unsuitable for steam power as mentioned, but that circular or round ploughs alone, or in combination with common ploughs would suit. Facts known in the history of the steam engine had their influence. In the first attempts to propel boats by the vapor of water, it was applied to oars or paddles, resulting in failure; but when the common paddle-wheel or propeller was tried, success followed. Again, the manufacture of the most useful article man possesses, iron, was slow and costly by the trip hammer, even when worked with steam, but the use of squeezers and round rollers has immensely increased the production of bar iron and reduced the price to a figure that it is within the reach of all.

Experiments by horse power with circular ploughs terminated so, that it was believed that with steam power they would, at one operation, plough and pulverise the ground to an extent that

would enable the agriculturist to plant forthwith when desirable, or in other words, plough to-day and plant to-morrow.

Drawings for a light, powerful traction engine were made, the main and minor parts of which were to be made of wood, excepting the boilers, engines, &c., and with the same object (lightness) in view it was also determined that all shafting—excepting the engine's shafts and windlasses—should be made of gas pipe.

A model of large size, on a regular scale, by the drawings, was made, of the main frame, fore and driving wheels, &c., and when completed, looked and performed well. Here it will be mentioned that during over a quarter of a century devoted to varied mechanical pursuits, we have made quite a number of models, and in no instance when properly made have they failed to exhibit plainly, frame work, or the working of machinery or machines made in conformity to them.

On completion of the fore, driving wheels, and main frame, the latter was mounted on the axles of the former, and, notwithstanding the strength of one man would move the whole concern on a level floor, it was evident that the fore wheels were of too small diameter (3½ feet) for running on yielding or rough ground. It was also evident that the axel (3½ inch gas pipe) of the driving wheels, with only inside bearings, had not strength to bear the weight of the boiler, engines, &c.

The model was remodelled for six feet diameter (one foot less than the driving wheels) fore wheels, and a frame for the driving wheels, that would permit short axles and double bearings for each wheel. It is believed that time will prove the alterations mentioned no small improvement in traction engines for running on the ground, especially rough ground. When the new fore wheels and frame mentioned were completed, and the main frame mounted on the same, two men's strength moved the whole on hard level ground. It will be proper to state that the traction engine thus far made was intended for engines of seven or eight inches diameter of cylinders, to work steam expansively, and the tread or verge of the driving wheels smooth, without spurs, &c., for traction (adhesion of the wheels to the ground) in order that the traction

of smooth wheels could be definitely noted previous to spurs being added, if wanted for circular ploughs.

Fawkes' steam plough had traction for six common ploughs, cutting one foot each on firm ground, without spurs or other projections on the driving drum. (Patent office report, 1869, page 309.)

Two engines (second hand) $5\frac{1}{2} \times 14$ were nearest the size mentioned that limited means would get, one of them being a horizontal common slide valve, the other a vertical uncommon slide valve engine, together with a vertical tubular boiler 6 feet long and 3 feet diameter.

The engines and boiler in place on the main and driving wheel frames, steam was raised and the horizontal engine worked well, but the other would not, for want of steam in the cylinder. On examination, a wooden plug was found in the steampipe leading to it, which was taken out and steam again got up, when both engines apparently worked well, being connected to the same shaft, their cranks at right angles. When there was about 40 pounds of steam, a pilot at the wheel, and the counter shaft's couplings shipped up, steam was let into the engines—forthwith the traction engine moved a short distance (to a canal) in a straight line. The pilot, by a few turns of his wheel, brought the fore wheels in a position for turning around short, or in a circle; thus about a half-dozen round turns or circles were made, the outermost fore wheel running inside a circle of 19 feet, the driving wheel (outside) a circle of 9 feet, and the inside driving wheel a circle of less than 3 feet; in fact the traction engine turning round on little more than its own ground.

The pilot was instructed to make the last round or circle as large as the nature of the ground would permit. In so doing, one of the driving wheels ran into an old well or sink that had been filled up, and sank near a foot, stopping the machine. The use of levers, etc., by about a half-dozen men, soon raised the wheel, and the traction engine proceeded to the place where it started from.

At the first trial of the traction engine, or steam mule Eve,

the engines were temporarily attached to a stiff or single shaft, and but one driving chain's wheel and pinion were used—which were too inconvenient for practical use. The shaft was cut in the middle and provided with a pin coupling, so that when coupled up, the engine cranks were as before—at right angles—and a pair of roller driving chains, wheels and pinions in lieu of the single ones.

On trial, with the engines separated, the uncommon sticle valve (sticle and reversing valve together,) engine would not work with half as much power as the other, and notwithstanding the advice of prominent engineers was followed, it was difficult to remedy the matter, in consequence of the wrist mortise in the return crank being cast wrong. In addition, the steam openings were so small that the engine was condemned by some engineers. Nevertheless, it was determined to attempt ploughing with a single common plough of the Calhoun pattern. With steam at 50 lbs., without a pilot, lashed the helm, in sailor parlance, for a straight run, with the engines coupled, the plough without a coulter, cut on hard ground, (an old brick yard,) six inches deep and within a fraction of twelve inches wide, without the slightest difficulty, other than the uncommon engine did not work with the same power as the other.

The steam mule again in harness for service, the water in the boiler foamed badly, the engine last mentioned working so much of the same with the steam, that the motion or speed of both engines was irregular to an extent that caused the front part of the machine to jump or jog up and down considerably. This was in part produced by the cogs of the driving pinions being rather long, and too deep in gear. In making a greater turn across a ditch, with only one pin (made for two) in the engine's coupling, the inner end of one of the engine's shaft timbers was split slightly. To prevent a recurrence of the same, and for greater convenience, it was thought best to have a new coupling without pins. A new coupling in place, the traction engine ran a short distance, when one of the driving wheels encountered a mud hole about six inches deep—progression was stopped—steam down to

30 lbs., with fine slack coal for fuel and no smoke stack. Sixty pounds of steam soon overcame the difficulty, running on to a cross road, which by a quarter turn was gained without stopping, proceeding on to another road that led back to the starting place, which was soon reached without detention, except occasional stops to get up steam. Trials thus far indicating that a steam drum was indispensable, one was obtained and put on top of the boiler, inside the smoke stack space, to increase the heating surface, superheat the steam and prevent under ordinary circumstances the engines working water. Steam was raised to try the drum and haul some plank, in wheeling across a ditch, with the power of both engines on one of the counter-shafts, ($2\frac{1}{2}$ inch gas pipe,) it twisted and bent in such a way that it was useless, when the the steam mule was backed without much difficulty to its quarters.

By the time a new shaft of solid iron was in its place, the firemen's *fête champêtre* was in full progress. To aid in giving variety on that memorable occasion, steam was got up and Eve moored in the proper direction for the *fête* ground. In rounding the first corner, a delay of a few minutes occurred, in consequence of the new counter shaft coupling not being properly adjusted. As soon as this was remedied, progression was made, with *eclat*, down and up the road in front of the assembled throng.

(*To be continued.*)

DETERMINATION OF THE YIELD OF CRUDE SUGAR.

By M. Scheibler.

To value a sample of crude sugar, the author treats it with alcohol mixed with acetic acid, and already saturated with sugar. The apparatus consists of two flat-bottomed flasks. The first, of 50 c.c. capacity, has a stopper cut sloping to admit of the circulation of air. It is perforated with two holes, through which pass a short tube designed for the introduction of the exhaustion liquids, and a tube reaching to the bottom, and widened at its

lower end, over which is stretched a piece of flannel to serve as a filter. This filter-tube is externally connected with the second flask by means of a caoutchouc tube. The latter, 100 c.c. in capacity, is fitted with a tube for connecting with the former flask, and another tube, short, and fitted externally with a caoutchouc tube and a pinchcock. This flask serves as an aspirator when a partial vacuum is made in it. A weighed quantity of the sugar under examination is placed in the first flask, and successively exhausted with the following liquids:—(1) Alcohol at 85 per cent., containing 50 c.c. of acetic acid per litre, and saturated with pure sugar; (2) alcohol at 92 per cent.; (3) alcohol at 96 per cent., both saturated with sugar. These three liquids are kept in bottles along with an excess of sugar-candy. Finally, the sugar is washed with a few drops of absolute alcohol, then dissolved in water, and examined with the saccharimeter.

BRITISH ASSOCIATION.

(*Professor Tyndall's Address concluded from page* 480.)

Towards the close of the stationary period a word-weariness, if I may so express it, took more and more possession of men's minds. Christendom had become sick of the school philosophy and its verbal wastes, which led to no issue, but left the intellect in everlasting haze. Here and there was heard the voice of one impatiently crying in the wilderness, "Not unto Aristotle, not unto subtle hypotheses, not unto church, bible or blind tradition, must we turn for a knowledge of the universe, but to the direct investigation of nature by observation and experiment." In 1543, the epoch-making work of Copernicus on the paths of the heavenly bodies appeared. The total crash of Aristotle's closed universe with the earth at its centre followed as a consequence; and "the earth moves" became a watchword among intellectual freemen. Copernicus was Canon of the church of Frauenburg, in the diocese of Ermeland. For three and thirty years he had withdrawn himself from the world and devoted himself to the consolidation of his great scheme of the solar system. He made its blocks eternal; and even to those who feared it and desired its overthrow it was so obviously strong that they refrained for a time from meddling with it. In

the last year of the life of Copernicus his book appeared: it is said that the old man received a copy of it a few days before his death, and then departed in peace.

The Italian philosopher Giordano Bruno was one of the earliest converts to the new astronomy. Taking Lucretius as his exemplar, he revived the notion of the infinity of worlds; and combining with it the doctrine of Copernicus, reached the sublime generalisation that the fixed stars are suns, scattered numberless through space and accompanied by satellites, which bear the same relation to them that our earth does to our sun, or our moon to our earth. This was an expansion of transcendent import; but Bruno came closer than this to our present line of thought. Struck with the problem of the generation and maintenance of organisms, and duly pondering it, he came to the conclusion that Nature in her productions does not imitate the technic of man. Her process is one of unravelling and unfolding. The infinity of forms under which matter appears were not imposed upon it by an external artificer; by its own intrinsic force and virtue it brings these forms forth. Matter is not the mere naked, empty capacity which philosophers have pictured her to be, but the universal mother, who brings forth all things as the fruit of her own womb.

This outspoken man was originally a Dominican monk. He was accused of heresy and had to fly, seeking refuge in Geneva, Paris, England, and Germany. In 1592 he fell into the hands of the Inquisition at Venice. He was imprisoned for many years, tried, degraded, excommunicated, and handed over to the Civil power, with the request that he should be treated gently and "without the shedding of blood." This meant that he was to be burnt; and burnt accordingly he was, on the 16th of February, 1600. To escape a similar fate Galileo, thirty-three years afterwards, abjured, upon his knees and with his hand upon the holy gospels, the heliocentric doctrine. After Galileo came Kepler, who from his German home defied the power beyond the Alps. He traced out from pre-existing observations the laws of planetary motion. The problem was thus prepared for Newton, who bound those empirical laws together by the principles of gravitation.

During the Middle Ages the doctrine of atoms had to all appearance vanished from discussion In all probability it held its ground among sober-minded and thoughtful men, though neither the church nor the world was prepared to hear of it with tolerance. Once, in the year 1348, it received distinct expression. But retraction by compulsion immediately followed, and thus discouraged, it slumbered till the 17th century, when it was revived by a contemporary of Hobbes and Descartes, the Père Gassendi.

The analytic and synthetic tendencies of the human mind exhibit themselves throughout history, great writers ranging themselves sometimes on the one side, sometimes on the other. Men of lofty feelings, and minds open

to the elevating impressions produced by nature as a whole, whose satisfaction, therefore, is rather ethical than logical, have leaned to the synthetic side; while the analytic harmonises best with the more precise and more mechanical bias which seeks the satisfaction of the understanding. Some form of pantheism was usually adopted by the one, while a detached Creator, working more or less after the manner of men, was often assumed by the other.* Gassendi is hardly to be ranked with either. Having formally acknowledged God as the great first cause, he immediately drops the idea, applies the known laws of mechanics to the atoms, thence deduces all vital phenomena. God, who created earth and water, plants and animals, produced, in the first place, a definite number of atoms, which constituted the seed of all things. Then began that series of combinations and decompositions which goes on at the present day, and which will continue in the future. The principle of every change resides in matter. In artificial productions the moving principle is different from the material worked upon; but in nature the agent works within, being the most active and mobile part of the material itself. Thus this bold ecclesiastic, without incurring the censure of the church or of the world, contrives to outstrip Mr. Darwin. The same cast of mind which caused him to detach the Creator from his universe led him also to detach the soul from the body, though to the body he ascribes an influence so large as to render the soul almost unnecessary. The aberrations of reason were in his view an affair of the material brain. Mental disease is brain-disease; but then the immortal reason sits apart, and cannot be touched by the disease. The errors of madness are errors of the instrument, not of the performer.

It may be more than a mere result of education, connecting itself probably with the deeper mental structure of the two men, that the idea of Gassendi, above enunciated, is substantially the same as that expressed by Professor Clerk Maxwell at the close of the very noble lecture delivered by him at Bradford, last year. According to both philosophers, the atoms, if I understand aright, are the prepared materials, the "manufactured articles," which, formed by the skill of the Highest, produce by their subsequent inter-action all the phenomena of the material world. There seems to be this difference, however, between Gassendi and Maxwell. The one postulates, the other infers his first cause. In his manufactured articles, Professor Maxwell finds the basis of an induction, which enables him to scale philosophic heights considered inaccessible by Kant, and to take the logical step from the atoms to their Maker.

The atomic doctrine, in whole or in part, was entertained by Bacon,

* Boyle's model of the universe was the Strasburg clock with an outside Artificer. Goethe, on the other hand sang

"Ihm ziemt's die Welt im Innern zu bewegen,
Natur in sich, sich in Natur zu hegen."

The same repugnance to the Clockmaker conception is manifest in Carlyle.

Descartes, Hobbes, Locke, Newton, Boyle, and their successors, until the chemical law of multiple proportions enabled Dalton to confer upon it an entirely new significance. In our day there are secessions from the theory, but it still stands firm. Only a year or two ago Sir William Thompson, with characteristic penetration, sought to determine the sizes of the atoms, or rather to fix the limits between which their sizes lie; whilst only last year the discourses of Williamson and Maxwell illustrate the present hold of the doctrine upon the foremost scientific minds. What these atoms, self-moved and self-posited, can and cannot accomplish in relation to life, is at the present moment the subject of profound scientific thought. I doubt the legitimacy of Maxwell's logic; but it is impossible not to feel the ethic glow with which his lecture concludes. There is, moreover, a Lucretian grandeur in his description of the steadfastness of the atoms:—"Natural causes, as we know, are at work, which tend to modify, if they do not at length destroy, all the arrangements and dimensions of the earth and the whole solar system. But though in the course of ages catastrophes have occurred and may yet occur in the heavens, though ancient systems may be dissolved and new systems evolved out of their ruins, the molecules out of which these systems are built, the foundation stones of the material universe, remain unbroken and unworn."

Ninety years subsequent to Gassendi the doctrine of bodily instruments, as it may be called, assumed immense importance in the hands of Bishop Butler, who in his famous "Analogy of Religion," developed from his own point of view and with consummate sagacity, a similar idea. The Bishop still influences superior minds; and it will repay us to dwell for a moment on his views. He draws the sharpest distinction between our real selves and our bodily instruments. He does not, as far as I remember, use the word "soul," possibly because the term was so hackneyed in his day, as it had been for many generations previously. But he speaks of "living powers,' "perceiving," or "percipient powers," "moving agents," "ourselves," in the same sense as we should employ the term "soul." He dwells upon the fact that the limbs may be removed, and mortal diseases assail the body, while the mind, almost up to the moment of death, remains clear. He refers to sleep and to swoon, where the "living powers" are suspended but not destroyed. He considers it quite as easy to conceive of an existence out of our bodies as in them; that we may animate a succession of bodies, the dissolution of all of them having no more tendency to dissolve our real selves, or "deprive us of living faculties—the faculties of perception and action—than the dissolution of any foreign matter which we are capable of receiving impressions from, or making use of for the common occasions of life." This is the key of the Bishop's position: "our organised bodies are no more a part of ourselves than any other matter around us." In proof of this he calls attention to the use of glasses, which "prepare objects" for the

"percipient power" exactly as the eye does. The eye itself is no more percipient than the glass, and is quite as much the instrument of the true self, and also as foreign to the true self, as the glass is. "And if we see with our eyes only in the same manner as we do with glasses, the like may justly be concluded from analogy of all our senses."

Lucretius, as you are aware, reached a precisely opposite conclusion; and it certainly would be interesting, if not profitable, to us all, to hear what we would or could urge in opposition to the reasoning of the Bishop. As a brief discussion of the point will enable us to see the bearings of an important question, I will here permit a disciple of Lucretius to try the strength of the Bishop's position, and then allow the Bishop to retaliate, with the view of rolling back, if we can, the difficulty upon Lucretius. Each shall state his case fully and frankly; and you shall be umpire between them.

The argument might proceed in this fashion:

"Subjected to the test of mental presentation (*Vorstellung*) your views, most honoured prelate, would present to many minds a great, if not an insuperable difficulty. You speak of 'living powers,' 'percipient or perceiving powers,' and 'ourselves;' but can you form a mental picture of any one of these apart from the organism through which it is supposed to act? Test yourself honestly, and see whether you possess any faculty that would enable you to form such a conception. The true self has a local habitation in each of us; thus localised, must it not possess a form? If so, what form? Have you ever for a moment realised it? When a leg is amputated the body is divided into two parts; is the true self in both of them or in one? Thomas Aquinas might say in both; but not you, for you appeal to the consciousness associated with one of the two parts to prove that the other is foreign matter. Is consciousness then, a necessary element of the true self? If so, what do you say to the case of the whole body being deprived of consciousness? If not, then on what grounds do you deny any portion of the true self to the severed limb? It seems very singular that, from the beginning to the end of your admirable book (and no one admires its sober strength more than I do), you never once mention the brain or nervous system. You begin at one the end of the body, and show that its parts may be removed without prejudice to the perceiving power. What if you begin at the other end, and remove, instead of the leg, the brain? The body, as before, is divided into two parts; but both are now in the same predicament, and neither can be appealed to to prove that the other is foreign matter. Or, instead of going so far as to remove the brain itself, let a certain portion of its bony covering be removed, and let a rhythmic series of pressures and relaxations of pressure be applied to the soft substance. At every pressure 'the faculties of perception and of action' vanish; at every relaxation of pressure they are restored. Where, during the intervals of pressure, is the perceiving power? I once had the discharge of a large Leyden battery passed unexpectedly

through me: I felt nothing, but was simply blotted out of conscious existence for a sensible interval. Where was my true self during that interval? Men who have recovered from lightning-stroke have been much longer in the same state: and indeed in cases of ordinary concussion of the brain, days may elapse during which no experience is registered in consciousness. Where is the man himself during the period of insensibility? You may say that I beg the question when I assume the man to have been unconscious, that he was really conscious all the time, and has simply forgotten what has occurred to him. In reply to this, I can only say that no one need s[illegible]ink from the worst tortures that superstition ever intended if only so felt and so remembered. I do not think your theory of instruments goes at all to the bottom of the matter. A telegraph operator has his instruments, by means of which he converses with the world; our bodies possess a nervous system, which plays a similar part between the perceiving power and external things. Cut the wires of the operator, break his battery, demagnetise his needle: by this means you certainly sever his connection with the world; but inasmuch as these are real instruments, their destruction does not touch the man who uses them. The operator survives, and he knows that he survives. What is it, I would ask, in the human system that answers to this conscious survival of the operator when the battery of the brain is so disturbed as to produce insensibility, or when it is destroyed altogether?

"Another consideration, which you may consider slight, presses upon me with some force. The brain may change from health to disease, and through such a change the most exemplary man may be converted into a debauchee or a murderer. My very noble and approved good master had, as you know, threatenings of lewdness introduced into his brain by his jealous wife's philter; and sooner than permit himself to run even the risk of yielding to these base promptings he slew himself. How could the hand of Lucretius have been thus turned against himself if the real Lucretius remained as before? Can the brain or can it not act in this distempered way without the intervention of the immortal reason? If it cannot, then the immortal reason, by its mischievous activity in operating upon a broken instrument, must have the credit of committing every imaginable extravagance and crime. I think, if you will allow me to say so, that the gravest consequences are likely to flow from your estimate of the body. To regard the brain as you would a staff or an eye-glass—to shut your eyes to all its misery, to the perfect correlation that rains between its conditions and our consciousness, to the fact that a slight excess or defect of blood in it produces that very swoon to which you refer, and that in relation to it our meat, and drink, and air, and execrise have a perfectly transcendental value and significance—to forget all this does, I think, open a way to innumerable errors in our habits of life, and may possibly in some cases initiate and foster that very disease, and consequent mental ruin, which a wiser appreciation of this mysterious organ would have avoided."

I can imagine the Bishop thoughtful after hearing this argument. He was not the man to allow anger to mingle with the consideration of a point of this kind. After due consideration, and having strengthened himself by that honest contemplation of the facts, which was habitual with him, and includes the desire to give even adverse facts their due weight, I can suppose the Bishop to proceed thus:—"You will remember that in the 'Analogy of Religion,' of which you have so kindly spoken, I did not profess to prove anything absolutely, and that I over and over again acknowledged and insisted on the smallness of our knowledge, or rather the depth of our ignorance, as regards the whole system of the universe. My object was to show my deistical friends, who set forth so eloquently the beauty and beneficence of Nature and the Ruler thereof, while they had nothing but scorn for the so-called absurdities of the Christian scheme, that they were in no better condition than we were, and that, for every difficulty they found upon our side, quite as great a difficulty was to be found upon theirs. I will now, with your permission, adopt a similar line of argument. You are a Lucretian, and from the combination and separation of atoms deduce all terrestrial things, including organic forms and their phenomena. Let me tell you in the first instance how far I am prepared to go with you. I admit that you can build crystalline forms out of this play of molecular force; that the diamond, amethyst, and snow-star are truly wonderful structures which are thus produced. I will go further and acknowledge that even a tree or flower might in this way be organised. Nay, if you can show me an animal without sensation, I will concede to you that it also might be put together by the suitable play of molecular force.

"Thus far our way is clear, but now comes my difficulty. Your atoms are individually without sensation, much more are they without intelligence. May I ask you, then, to try your hand upon this problem. Take your dead hydrogen atoms, your dead oxygen atoms, your dead carbon atoms, your dead nitrogen atoms, your dead phosphorus atoms, and all the other atoms, dead as grains of shot, of which the brain is formed. Imagine them separate and sensationless; observe them ruuning together and forming all imagine able combinations. This, as a purely mechanical process, is seeable by the mind. But can you see, or dream, or in any way imagine how, out of that mechanical act, and from these individually dead atoms, sensation, thought, and emotion are to arise? You speak of the difficulty of mental presentation in my case; is it less in yours? I am not all bereft of this *Vorstellungs-Kraft* of which you speak. I can follow a particle of musk until it reaches the olfactory nerve; I can follow the waves of sound until their tremors reach the waters of the labyrinth, and set the otoliths and Corti's fibres in motion; I can also visualise the waves of ether as they cross the eye and

hit the retina. Nay more, I am able to follow up to the central organ the motion thus imparted at the periphery, and to see in idea the very molecules of the brain thrown into tremors. My insight is not baffled by these physical processes. What baffles me, what I find unimaginable, transcending every faculty I possess—transcending, I humbly submit—every faculty you possess—is the notion that out of those physical tremors you can extract things so utterly incongruous with them as sensation, thought, and emotion. You say, or think, that this issue of consciousness from the clash of atoms is not more incongruous than the flash of light from the union of oxygen and hydrogen. But I beg to say that it is. For such incongruity as the flash possesses is that which I now force upon your attention. The flash is an affair of consciousness, the objective counterpart of which is a vibration. If is a flash only by your interpretation. You are the cause of the apparent incongruity; and you are the thing that puzzles me. I need not remind you that the great Leibnitz felt the difficulty which I feel, and that to get rid of this monstrous deduction of life from death he displaced your atoms by his monads, which were more or less perfect mirrors of the universe, and out of the summation and integration of which he supposed all the phenomena of life—sentient, intellectual, and emotional—to arise.

"Your difficulty, then, as I see you ready to admit, is quite as great as mine. You cannot satisfy the human mind in its demand for logical continuity between molecular processes and the phenomena of consciousness. This is a rock on which materialism must inevitably split whenever it pretends to be a complete philosophy of life. What is the moral, my Lucretian? You and I are not likely to indulge in ill-temper in the discussion of these great topics where we see so much room for honest differences of opinion. But there are people of less wit, or more bigotry (I say it with humility) on both sides, who are ever ready to mingle anger and vituperation with such discussions. There are, for example, writers of note and influence at the present day who are not ashamed to assume the 'deep personal sin' of a great logician to be the cause of his unbelief in a theologic dogma. And there are others that hold that we, who cherish our noble Bible, wrought as it has been into the constitution of our forefathers, and by inheritance into us, must necessarily be hypocritical and insincere. Let us disavow and discountenance such people, cherishing the unswerving faith that what is good and true in both our arguments will be preserved for the benefit of humanity, while all that is bad or false will disappear."

It is worth remarking that in one respect the Bishop was a product of his age. Long previous to his day the nature of the soul had been so favourite and general a topic of discussion, that, when the students of the University of Paris wished to know the leanings of a new Professor, they at once requested him to lecture upon the soul. About the time of Bishop Butler

the question was not only agitated, but extended. It was seen by the clear-witted men who entered this arena that many of their best arguments applied equally to brutes and men. The Bishop's arguments were of this character. He saw it, admitted it, accepted the consequences, and boldly embraced the whole animal world in his scheme of immortality.

Bishop Butler accepted with unwavering trust the chronology of the Old Testament, describing it as "confirmed by the natural and civil history of the world, collected from common historians, from the state of the earth, and from the late inventions of arts and sciences." These words mark progress; they must seem somewhat hoary to the Bishop's successors of to-day.* It is hardly necessary to inform you that since his time the domain of the naturalist has been immensely extended—the whole science of geology, with its astounding revelations regarding the life of the ancient earth, having been created. The rigidity of old conceptions has been relaxed, the public mind being rendered gradually tolerant of the idea that not for six thousand, nor for sixty thousand, nor for six thousand thousand, but for æons embracing untold millions of years, this earth has been the theatre of life and death. The riddle of the rocks has been read by the geologist and palæontologist, from subcambrian depths to the deposits thickening over the sea-bottoms of to-day. And upon the leaves of that stone book are, as you know, stamped the characters, plainer and surer than those formed by the ink of history, which carry the mind back into abysses of past time compared with which the periods which satisfied Bishop Butler cease to have a visual angle. Everybody now knows this; all men admit it; still when they were first broached these varieties of science found loud-tongued denunciators, who proclaimed not only their baselessness considered scientifically, but their immorality considered as questions of ethics and religion; the Book of Genesis had stated the question in a different fashion; and science must necessarily go to pieces when it clashed with this authority. And as the seed of a thistle produces a thistle, and nothing else, so these objectors scatter their germs abroad, and reproduce their kind, ready to play again the part of their intellectual progenitors, to show the same virulence, the same ignorance, to achieve for a time the same success, and finally to suffer the same inexorable defeat. Surely the time must come at last when human nature in its entirety, whose legitimate demands it is admitted science alone cannot satisfy, will find interpreters and expositors of a different stamp from those rash and ill-informed persons who have been hitherto so ready to hurl themselves against every new scientific revelation, lest it should endanger what they are pleased to consider theirs.

* Only to some; for there are dignitaries who even now speak of the earth's rocky crust as so much building material prepared for man at the Creation. Surely it is time that this loose language should cease.

The lode of discovery once struck, those petrified forms in which life was at one time active, increased to multitudes and demanded classification. The general fact soon became evident that none but the simplest forms of life lie lowest down, that as we climb higher and higher among the super-imposed strata more perfect forms appear. The change, however, from form to form was not continuous—but by steps, some small, some great. "A section," says Mr. Huxley, "a hundred feet thick will exhibit at different heights a dozen species of Ammonite, none of which passes beyond its particular zone of limestone, or clay, into the zone below it, or into that above it." In the presence of such facts it was not possible to avoid the question:—Have these forms, showing, though in broken stages and with many irregularities, this unmistakable general advance, been subjected to no continuous law of growth or variation? Had our education been purely scientific, or had it been sufficiently detached from influences which, however ennobling in another domain, have always proved hindrances and delusions when introduced as factors into the domain of physics, the scientific mind never could have swerved from the search for a law of growth, or allowed itself to accept the anthropomorphism which regarded each successive stratum as a kind of mechanic's bench for the manufacture of new species out of all relation to the old.

Biased, however, by their previous education, the great majority of naturalists invoked a special creative act to account for the appearance of each new group of organisms. Doubtless there were numbers who were clear-headed enough to see that this was no explanation at all, that in point of fact it was an attempt, by the introduction of a greater difficulty, to account for a less. But having nothing to offer in the way of explanation, they for the most part held their peace. Still the thoughts of reflecting men naturally and necessarily simmered round the question. De Maillet, a contemporary of Newton, has been brought into notice by Professor Huxley as one who "had a notion of the modifiability of living forms." In my frequent conversations with him, the late Sir Benjamin Brodie, a man of highly philosophic mind, often drew my attention to the fact that, as early as 1794, Charles Darwin's grandfather was the pioneer of Charles Darwin. In 1801, and in subsequent years, the celebrated Lamarck, who produced so profound an impression on the public mind through the vigorous exposition of his views by the author of the "Vestiges of Creation," endeavoured to show the development of species out of changes of habit and external condition. In 1813, Dr. Wells, the founder of our present Theory of Dew, read before the Royal Society a paper in which, to use the words of Mr. Darwin, "he distinctly recognises the principal of natural selection; and this is the first recognition that has been indicated." The thoroughness

and skill with which Wells pursued his work, and the obvious independence of his character, rendered him long ago a favourite with me; and it gave me the liveliest pleasure to alight upon this additional testimony to his penetration. Professor Grant, Mr. Patrick Matthew, Von Buch, the author of the "Vestiges," D'Halloy, and others,* by the enunciation of views more or less clear and correct, showed that the question had been fermenting long prior to the year 1858, when Mr. Darwin and Mr. Wallace simultaneously but independently placed their closely concurrent views upon the subject before the Linnean Society.

These papers were followed in 1859 by the publication of the first edition of the "Origin of Species." All great things come slowly to the birth. Copernicus, as I informed you, pondered his great work for thirty-three years. Newton for nearly twenty years kept the idea of gravitation before his mind; for twenty years also he dwelt upon his discovery of fluxions, and doubtless would have continued to make it the object of his private thought had he not found that Leibnitz was upon his track. Darwin for two-and-twenty years pondered the problem of the origin of species, and doubtless he would have continued to do so had he not found Wallace upon his track.† A concentrated, but full and powerful epitome of his labours was the consequence. The book was by no means an easy one; and probably not one in every score of those who then attacked it had read its pages through, or were competent to grasp their significance if they had. I do not say this merely to discredit them; for there were in those days some really eminent scientific men, entirely raised above the heat of popular prejudice, willing to accept any conclusion that science had to offer, provided it was duly backed by fact and argument, and who entirely mistook Mr. Darwin's views. In fact the work needed an expounder; and it found one in Mr. Huxley. I know nothing more admirable in the way of scientific exposition than those early articles of his on the origin of species. He swept the curve of discussion through the really significant points of the subject, enriched his exposition with profound original remarks and reflections, often summing up in a single pithy sentence an argument which a less compact mind would have spread over pages. But there is one impression made by the book itself which no exposition of it, however luminous, can convey, and that is the impression of the vast amount of labour, both of observation and of thought, implied in its production. Let us glance at its principles.

* In 1855, Mr. Herbert Spencer ("Principles of Psychology," 2nd edit., vol. i., p. 465) expressed "the belief that life under all its forms has arisen by an unbroken evolution, and through the instrumentality of what are called natural causes."

† The behaviour of Mr. Wallace in relation to this subject has been dignified in the highest degree.

It is conceded on all hands that what are called varieties are continually produced. The rule is probably without exception. No chick and no child is in all respects and particulars the counterpart of its brother or sister; and in such differences we have "variety" incipient. No naturalist could tell how far this variation could be carried; but the great mass of them held that never by any amount of internal or external change, nor by the mixture of both, could the offspring of the same progenitor so far deviate from each other as to constitute different species. The function of the experimental philosopher is to combine the conditions of nature, and to produce her results; and this was the method of Darwin.* He made himself acquainted with what could, without any manner of doubt, be done in the way of producing variation. He associated himself with pigeon-fanciers—bought, begged, kept, and observed every breed that he could obtain. Though derived from a common stock, the diversities of these pigeons were such that "a score of them might be chosen which, if shown to an ornithologist, and he were told that they were wild birds, would certainly be ranked by him as well-defined species." The simple principle which guides the pigeon-fancier, as it does the cattle-breeder, is the selection of some variety that strikes his fancy, and the propagation of this variety by inheritance. With his eye still upon the particular appearance which he wishes to exaggerate, he selects it as it reappears in successive broods, and thus adds increment to increment until an astonishing amount of divergence from the parent type is effected. Man in this case does not produce the elements of the variation. He simply observes them, and by selection adds them together until the required result has been obtained. "No man," says Mr. Darwin, "would ever try to make a fantail till he saw a pigeon with a tail developed in some slight degree in an unusual manner, or a pouter until he saw a pigeon with a crop of unusual size. Thus nature gives the hint, man acts upon it, and by the law of inheritance exaggerates the deviation.

Having thus satisfied himself by indubitable facts that the organisation of an animal or of a plant (for precisely the same treatment applies to plants) is to some extent plastic, he passes from variation under domestication to variation under nature. Hitherto we have dealt with the adding together of small changes by the conscious selection of man. Can Nature thus select? Mr. Darwin's answer is, "Assuredly she can." The number of living things produced is far in excess of the number that can be supported; hence at some period or other of their lives there must be a struggle for existence; and what is the infallible result? If one

* The first step only towards experimental demonstration has been taken. Experiments now begun might, a couple of centuries hence, furnish data of incalculable value, which ought to be supplied to the science of the future.

organism were a perfect copy of the other in regard to strength, skill, and agility, external conditions would decide. But this is not the case. Here we have the fact of variety offering itself to nature, as in the former instance it offered itself to man; and those varieties which are least competent to cope with surrounding conditions will infallibly give way to those that are most competent. To use a familiar proverb, the weakest come to the wall. But the triumphant fraction again breeds to overproduction, transmitting the qualities which secured its maintenance, but transmitting them in different degrees. The struggle for food again supervenes, and those to whom the favourable quality has been transmitted in excess will assuredly triumph. It is easy to see that we have here the addition of increments favourable to the individual still more rigorously carried out than in the case of domestication; for not only are unfavourable specimens not selected by nature, but they are destroyed. This is what Mr. Darwin calls "Natural Selection," which "acts by the preservation and accumulation of small inherited modifications, each profitable to the preserved being." With this idea he interpenetrates and leavens the vast store of facts that he and others have collected. We cannot, without shutting our eyes through fear or prejudice, fail to see that Darwin is here dealing, not with imaginary, but with true causes; nor can we fail to discern what vast modifications may be produced by natural selection in periods sufficiently long. Each individual increment may resemble what mathematicians call a "differential" (a quantity indefinitely small); but definite and great changes may obviously be produced by the integration of these infinitesimal quantities through practically infinite time.

If Darwin, like Bruno, rejects the notion of creative power acting after human fashion, it certainly is not because he is unacquainted with the numberless exquisite adaptations on which this notion of a supernatural artificer has been founded. His book is a repository of the most startling facts of this description. Take the marvellous observation which he cites from Dr. Crüger, where a bucket with an aperture, serving as a spout, is formed in an orchid. Bees visit the flower: in eager search of material for their combs they push each other into the bucket, the drenched ones escaping from their involuntary bath by the spout. Here they rub their backs against the viscid stigma of the flower and obtain glue; then against the pollen-masses, which are thus stuck to the back of the bee and carried away. "When the bee, thus provided, flies to another flower, or to the same flower a second time, and is pushed by its comrades into the bucket, and then crawls out by the passage, the pollen-mass upon its back necessarily comes first into contact with the viscid stigma," which takes up the pollen; and this is how that orchid is fertilised. Or take this other case of the *Catasetum*. "Bees visit these flowers in order to gnaw the labellum; on doing this they

inevitably touch a long, tapering, sensitive projection. This, when touched, transmits a sensation or vibration to a certain membrane, which is instantly ruptured, setting free a spring, by which the pollen-mass is shot forth like an arrow in the right direction, and adheres by its viscid extremity to the back of the bee." In this way the fertilising pollen is spread abroad.

It is the mind thus stored with the choicest materials of the teleologist that rejects teleology, seeking to refer these wonders to natural causes. They illustrate, according to him, the method of nature, not the "technic" of a man-like artificer. The beauty of flowers is due to natural selection. Those that distinguish themselves by vividly contrasting colours from the surrounding green leaves are most readily seen, most frequently visited by insects, most often fertilised, and hence most favoured by natural selection. Coloured berries also readily attract the attention of birds and beasts, which feed upon them, spread their manured seeds abroad, thus giving trees and shrubs possessing such berries a greater chance in ths struggle for existence.

With profound analytic and synthetic skill, Mr. Darwin investigates the cell-making instinct of the bee-hive. His method of dealing with it is representative. He falls back from the more perfectly to the less perfectly developed instinct—from the hive-bee to the humble-bee, which uses its own cocoon as a comb, and to classes of bees of intermediate skill, endeavouring to show how the passage might gradually be made from the lowest to the highest. The saving of wax is the most important point in the economy of bees. Twelve to fifteen pounds of dry sugar are said to be needed for the secretion of a single pound of wax. The quantities of nectar necessary for the wax must therefore be vast; and every improvement of constructive instinct which results in the saving of wax is a direct profit to the insect's life. The time that would otherwise be devoted to the making of wax is now devoted to the gathering and storing of honey for winter food. He passes from the humble-bee with its rude cells, through the Melipona with its more artistic cells, to the hive-bee with its astonishing architecture. The bees place themselves at equal distances apart upon the wax, sweep and excavate equal spheres round the selected points. The spheres intersect, and the planes of intersection are built up with thin laminæ. Hexagonal cells are thus formed. This mode of treating such questions is, as I have said, representative. He habitually retires from the more perfect and complex, to the less certain and simple, and carries you with him through stages of perfecting, adds increment to increment of infinitesimal change, and in this way gradually breaks down your reluctance to admit that the exquisite climax of the whole could be a result of natural selection.

Mr. Darwin shirks no difficulty; and, saturated as the subject was with his own thought, he must have known, better than his critics, the weakness as well as the strength of his theory. This of course would be of little avail

were his object a temporary dialectic victory instead of the establishment of a truth which he means to be everlasting. But he takes no pains to disguise the weakness he has discerned; nay, he takes every pains to bring it into the strongest light. His vast resources enable him to cope with objections started by himself and others, so as to leave the final impression upon the reader's mind that, if they be not completely answered, they certainly are not fatal. Their negative force being thus destroyed, you are free to be influenced by the vast positive mass of evidence he is able to bring before you. This largeness of knowledge and readiness of resource render Mr. Darwin the most terrible of antagonists. Accomplished naturalists have levelled heavy and sustained criticisms against him—not always with the view of fairly weighing his theory, but with the express intention of exposing its weak points only. This does not irritate him. He treats every objection with a soberness and thoroughness which even Bishop Butler might be proud to imitate, surrounding each fact with its appropriate detail, placing it in its proper relations, and usually giving it a significance which, as long as it was kept isolated, failed to appear. This is done without a trace of ill-temper. He moves over the subject with the passionless strength of a glacier; and the grinding of the rocks is not always without a counterpart in the logical pulverisation of the objector. But though in handling this mighty theme all passion has been stilled, there is an emotion of the intellect incident to the discernment of new truth which often colours and warms the pages of Mr. Darwin. His success has been great; and this implies not only the solidity of his work, but the preparedness of the public mind for such a revelation. On this head a remark of Agassiz impressed me more than anything else. Sprung from a race of theologians, this celebrated man combated to the last the theory of natural selection. One of the many times I had the pleasure of meeting him in the United States was at Mr. Winthrop's beautiful residence at Brooklyn, near Boston. Rising from luncheon, we all halted as if by common impulse in front of a window, and continued there a discussion which had been started at table. The maple was in its autumn glory; and the exquisite beauty of the scene outside seemed, in my case, to interpretate without disturbance the intellectual action. Earnestly, almost sadly, Agassiz turned, and said to the gentlemen standing round, "I confess that I was not prepared to see this theory received as it has been by the best intellects of our time. Its success is greater than I could have thought possible."

In our day great generalisations have been reached. The theory of the origin of species is but one of them. Another, of still wider grasp and more radical significance, is the doctrine of the Conservation of Energy, the ultimate philosophical issues of which are as yet but dimly seen—that doctrine which "binds nature fast in fate" to an extent not hitherto

recognised, exacting from every antecedent its equivalent consequent, from every consequent its equivalent antecedent, and bringing vital as well as physical phenomena under the dominion of that law of casual connexion which, as far as the human understanding has yet pierced, asserts itself everywhere in nature. Long in advance of all definite experiment upon the subject, the constancy and indestructibility of matter had been affirmed; and all subsequent experience justified the affirmation. Later researches extended the attribute of indestructibility to force. This idea, applied in the first instance to inorganic, rapidly embraced organic nature. The vegetable world, though drawing almost all its nutriment from invisible sources, was proved incompetent to generate anew either matter or force. Its matter is for the most part transmuted air; its force transformed solar force. The animal world was proved to be equally uncreative, all its motive energies being referred to the combustion of its food. The activity of each animal as a whole was proved to be the transferred activities of its molecules. The muscles were shown to be stores of mechanical force, potential until unlocked by the nerves, and then resulting in muscular contractions. The speed at which messages fly to and fro along the nerves was determined, and found to be, not as had been previously supposed, equal to that of light or electricity, but less than the speed of a flying eagle.

This was the work of the physicist: then came the conquests of the comparative anatomist and physiologist, revealing the structure of every animal, and the function of every organ in the whole biological series, from the lowest zoophyte up to man. The nervous system had been made the object of profound and continued study, the wonderful, and, at bottom, entirely mysterious, controlling power which it exercises over the whole organism, physical and mental, being recognised more and more. Thought could not be kept back from a subject so profoundly suggestive. Besides the physical life dealt with by Mr. Darwin, there is a psychical life presenting similar gradations, and asking equally for a solution. How are the different grades and orders of mind to be accounted for? What is the principle of growth of that mysterious power which on our planet culminates in reason? These are questions which, though not thrusting themselves so forcibly upon the attention of the general public, had not only occupied many reflecting minds, but had been formally broached by one of them before the "Origin of Species" appeared.

With the mass of materials furnished by the physicist and physiologist in his hands, Mr. Herbert Spencer, twenty years ago, sought to graft upon this basis a system of psychology; and two years ago a second and greatly amplified edition of his work appeared. Those who have occupied themselves with the beautiful experiments of Plateau will remember that when two spherules of olive-oil, suspended in a mixture of alcohol and water

of the same density as the oil, are brought together, they do not immediately unite. Something like a pellicle appears to be formed around the drops, the rupture of which is immediately followed by the coalescence of the globules into one. There are organisms whose vital actions are almost as purely physical as that of these drops of oil. They come into contact and fuse themselves thus together. From such organisms to others a shade higher, and from these to others a shade higher still, and on through an ever ascending series, Mr. Spencer conducts his argument. There are two obvious factors to be here taken into account—the creature and the medium in which it lives, or, as it is often expressed, the organism and its environment. Mr. Spencer's fundamental principle is, that between these two factors there is incessant interaction. The organism is played upon by the environment, and is modified to meet the requirements of the environment. Life he defines to be a "continuous adjustment of internal relations to external relations."

In the lowest organisms we have a kind of tactual sense diffused over the entire body; then through impressions from without and their corresponding adjustments, special portions of the surface become more responsive to stimuli than others. The senses are nascent, the basis of all of them being that simple tactual sense which the sage Democritus recognised 2,300 years ago as their common progenitor. The action of light, in the first instance, appears to be a mere disturbance of the chemical processes in the animal organism, similar to that which occurs in the leaves of plants. By degrees the action becomes localised in a few pigment-cells, more sensitive to the light than the surrounding tissue. The eye is here incipient. At first it is merely capable of revealing differences of light and shade produced by bodies close at hand. Followed as the interception of the light is in almost all cases by the contact of the closely adjacent opaque body, sight in this condition becomes a kind of "anticipatory touch." The adjustment continues; a slight bulging out of the epidermis over the pigment-granules supervenes. A lens is incipient, and, through the operation of infinite adjustments, at length reaches the perfection that it displays in the hawk and eagle. So of the other senses; they are special differentiations of a tissue which was originally vaguely sensitive all over.

With the development of the senses the adjustments between the organism and its environment gradually extend in space, a multiplication of experiences and corresponding modification of conduct being the result. The adjustments also extend in time, covering continually greater intervals. Along with this extension in space and time the adjustments also increase in speciality and complexity, passing through the various grades of brute life, and prolonging themselves into the domain of reason. Very striking are Mr. Spencer's remarks regarding the influence of the sense of touch upon

the development of intelligence. This is, so to say, the mother-tongue of all the senses, into which they must be translated to be of service to the organism. Hence its importance. The parrot is the most intelligent of birds, and its tactual power is also greatest. From this sense it gets knowledge unattainable by birds which cannot employ their feet as hands. The elephant is the most sagacious of quadrupeds—its tactual range and skill, and the consequent multiplication of experiences, which it owes to its wonderfully adaptable trunk, being the basis of its sagacity. Feline animals, for a similar cause, are more sagacious than hoofed animals—atonement being to some extent made, in the case of the horse, by the possession of sensitive prehensible lips. In the *Primates* the evolution of intellect and the evolution of tactual appendages go hand in hand. In the most intelligent anthropoid apes we find the tactual range and delicacy greatly augmented, new avenues of knowledge being thus opened to the animal. Man crowns the edifice here, not only in virtue of his own manipulatory power, but through the enormous extension of his range of experience, by the invention of instruments of precision, which serve as supplemental senses and supplemental limbs. The reciprocal action of these is finely described and illustrated. That chastened intellectual emotion to which I have referred in connection with Mr. Darwin is, I should say, not absent in Mr. Spencer. His illustrations possess at times exceeding vividness and force; and from his style on such occasions it is to be inferred that the ganglia of this apostle of the understanding are sometimes the seat of a nascent poetic thrill.

It is a fact of supreme importance that actions the performance of which at first requires even painful effort and deliberation, may by habit be rendered automatic. Witness the slow learning of its letters by a child, and the subsequent facility of reading in a man, when each group of letters which forms a word is instantly, and without effort, fused to a single perception. Instance the billiard-player, whose muscles of hand and eye, when he reaches the perfection of his art, are unconsciously co-ordinated. Instance the musician, who, by practice, is enabled to fuse a multitude of arrangements, auditory, tactual and muscular, into a process of automatic manipulation. Combining such facts with the doctrine of hereditary transmission, we reach a theory of instinct. A chick, after coming out of the egg, balances itself correctly, runs about, picks up food, thus showing that it possesses a power of directing its movements to definite ends. How did the chick learn this very complex co-ordination of eye, muscles, and beak? It has not been individually taught; its personal experience is *nil*; but it has the benefit of ancestral experience. In its inherited organisation are registered all the powers which it displays at birth. So also as regards the instinct of the hive-bee, already referred to. The distance at which the

insects stand apart when they sweep their hemispheres and build their cells is "organically remembered." Man also carries with him the physical texture of his ancestry as well as the inherited intellect bound up with it. The defects of intelligence during infancy and youth are probably less due to a lack of individual experience than to the fact that in early life the cerebral organisation is still incomplete. The period necessary for completion varies with the race and with the individual. As a round shot outstrips a rifled one on quitting the muzzle of the gun, so the lower race in childhood may outstrip the higher. But the higher eventually overtakes the lower, and surpasses it in range. As regards individuals, we do not always find the precocity of youth prolonged to mental power in maturity; while the dulness of boyhood is sometimes strikingly contrasted with the intellectual energy of after years. Newton, when a boy, was weakly, and he showed no particular aptitude at school; but in his eighteenth year he went to Cambridge, and soon afterwards astonished his teachers by his power of dealing with geometrical problems. During his quiet youth his brain was slowly preparing itself to be the organ of those energies which he subsequently displayed.

By myriad blows (to use a Lucretian phrase) the image and superscription of the external world are stamped as states of consciousness upon the organism, the depth of the impression depending upon the number of the blows. When two or more phenomena occur in the environment invariably together, they are stamped to the same depth or to the same relief, and indissolubly connected. And here we come to the threshold of a great question. Seeing that he could in no way rid himself of the consciousness of space and time, Kant assumed them to be necessary "forms of thought," the moulds and shapes into which our intuitions are thrown, belonging to ourselves solely and without objective existence. With unexpected power and success Mr. Spencer brings the hereditary experience theory, as he holds it, to bear upon this question. "If there exist certain external relations which are experienced by all organisms at all instants of their waking lives —relations which are absolutely constant and universal—there will be established answering internal relations that are absolutely constant and universal. Such relations we have in those of space and time. As the substratum of all other relations of the Non-Ego, they must be responded to by conceptions that are the substrata of all other relations in the Ego. Being the constant and infinitely repeated elements of thought, they must become the automatic elements of thought—the elements of thought which it is impossible to get rid of—the 'forms of intuition.'"

Throughout this application and extension of the "Law of Inseparable Association," Mr. Spencer stands on totally different ground from Mr. John Stuart Mill, invoking the registered experiences of the race instead of the

experiences of the individual. His overthrow of Mr. Mill's restriction of experience is, I think, complete. That restriction ignores the power of organising experience furnished at the outset to each individual; it ignores the different degrees of this power possessed by different races and by different individuals of the same race. Were there not in the human brain a potency antecedent to all experience, a dog or cat ought to be as capable of education as a man. These predetermined internal relations are independent of the experiences of the individual. The human brain is the "organised register of infinitely numerous experiences received during the evolution of life, or rather during the evolution of that series of organisms through which the human organism has been reached. The effects of the most uniform and frequent of these experiences have been successively bequeathed, principal and interest, and have slowly mounted to that high intelligence which lies latent in the brain of the infant. Thus it happens that the European inherits from twenty to thirty cubic inches more of brain than the Papuan. Thus it happens that faculties, as of music, which scarcely exist in some inferior races, become congenital in superior ones. Thus it happens that out of savages unable to count up to the number of their fingers, and speaking a language containing only nouns and verbs arise at length our Newtons and Shakspeares.

At the outset of this address it was stated that physical theories which lie beyond experience are derived by a process of abstraction from experience. It is instructive to note from this point of view the successive introduction of new conceptions. The idea of the attraction of gravitation was preceded by the observation of the attraction of iron by a magnet, and of light bodies by rubbed amber. The polarity of magnetism and electricity appealed to the senses, and thus became the substratum of the conception that atoms and molecules are endowed with definite attractive and repellant poles, by the play of which definite forms of crystalline architecture are produced. Thus molecular force becomes structural. It required no great boldness of thought to extend its play into organic nature, and to recognise in molecular force the agency by which both plants and animals are built up. In this way out of experience arise conceptions which are wholly ultra-experiential.

The origination of life is a point lightly touched upon, if at all, by Mr. Darwin and Mr. Spencer. Diminishing gradually the number of progenitors, Mr. Darwin comes at length to one "primordial form;" but he does not say, as far as I remember, how he supposes this form to have been introduced. He quotes with satisfaction the words of a celebrated author and divine who had "gradually learnt to see that it is just as noble a conception of the Deity to believe He created a few original forms, capable of self-development into other and needful forms, as to believe that He

required a fresh act of creation to supply the voids caused by the action of His laws." What Mr. Darwin thinks of this view of the introduction of life I do not know. Whether he does or does not introduce his "primordial form" by a creative act I do not know. But the question will inevitably be asked, "How came the form there?" With regard to the diminution of the number of created forms, one does not see that much advantage is gained by it. The anthropomorphism, which it seemed the object of Mr. Darwin to set aside, is as firmly associated with the creation of a few forms as with the creation of a multitude. We need clearness and thoroughness here. Two courses, and two only, are possible. Either let us open our doors freely to the conception of creative acts, or abandoning them let us radically change our notions of matter. If we look at matter, as pictured by Democritus, and as defined for generations in our scientific text-books, the absolute impossibility of any form of life coming out of it would be sufficient to render any other hypothesis preferable; but the definitions of matter given in our text-books were intended to cover its purely physical and mechanical properties. And taught as we have been to regard these definitions as complete, we naturally and rightly reject the monstrous notion that out of such matter any form of life could possibly arise. But are the definitions complete? Everything depends on the answer to be given to this question. Trace the line of life backwards, and see it approaching more and more to what we call the purely physical condition. We reach at length those organisms which I have compared to drops of oil suspended in a mixture of alcohol and water. We reach the *protogenes* of Haeckel, in which we have "a type distinguishable from a fragment of albumen only by its finely granular character." Can we pause here? We break a magnet, and find two poles in each of its fragments. We continue the process of breaking, but however small the parts, each carries with it though enfeebled, the polarity of the whole. And when we break no longer, we prolong the intellectual vision to the polar molecules. Are we not urged to do something similar in the case of life? Is there not a temptation to close to some extent with Lucretius, when he affirms that "nature is seen to do all things spontaneously of herself without the meddling of the gods?" or with Bruno, when he declares that matter is not "that mere empty capacity which philosophers have pictured her to be, but the universal mother who brings forth all things as the fruit of her own womb?" The questions here raised are inevitable. They are approaching us with accelerated speed, and it is not a matter of indifference whether they are introduced with reverence or with irreverence. Abandoning all disguise, the confession that I feel bound to make before you is, that I prolong the vision backward across the boundary of the experimental evidence, and discern in that matter which we in our ignorance, and notwithstanding our

professed reverence for its Creator, have hitherto covered with opprobrium, the promise and potency of every form and quality of life.

The "materialism" here enunciated may be different from what you suppose, and I therefore crave your gracious patience to the end. "The question of an external world," says Mr. J. S. Mill, "is the great battle-ground of metaphysics."* Mr. Mill himself reduces external phenomena to "possibilities of sensation." Kant, as we have seen, made time and space "forms" of our own intuitions. Fichte, having first by the inexorable logic of his understanding proved himself to be a mere link in that chain of causation which holds so rigidly in nature, violently broke the chain by making nature and all that it inherit an apparition of his own mind.† And it is by no means easy to combat such notions. For when I say I see you, and I have not the least doubt about it, the reply is, that what I am really conscious of is an affection of my own retina. And if I urge that I can check my sight of you by touching you, the retort would be that I am equally transgressing the limits of fact; for what I am really conscious of is, not that you are there, but that the nerves of my hand have undergone a change. All we hear, and see, and touch, and taste, and smell, are, it would be urged, mere variations of our own condition, beyond which, even to the extent of a hair's breadth, we cannot go. That anything answering to our impressions exists outside of ourselves is not a fact, but an inference, to which all validity would be denied by an idealist like Berkeley, or by a sceptic like Hume. Mr. Spencer takes another line. With him, as with the uneducated man, there is no doubt or question as to the existence of an external world. But he differs from the uneducated, who think that the world really is what consciousness represents it to be. Our states of consciousness are mere symbols of an outside entity which produces them and determines the order of their succession, but the real nature of which we can never know.‡ In fact, the whole process of evolution is the

* "Examination of Hamilton," p. 154.

† "Bestimmung des Menschen."

‡ In a paper, at once popular and profound, entitled "Recent Progress in the Theory of Vision," contained in the volume of Lectures by Helmholtz, published by Longmans, this symbolism of our states of consciousness is also dwelt upon. The impressions of sense are the mere signs of external things. In this paper Helmholtz contends strongly against the view that the consciousness of space is inborn; and he evidently doubts the power of the chick to pick up grains of corn without some preliminary lessons. On this point, he says, further experiments are needed. Such experiments have been since made by Mr. Spalding aided, I believe, in some of his observations by the accomplished and deeply lamented Lady Amberley; and they seem to prove conclusively that the chick does not need a single moment's tuition to teach it to stand, run, govern the muscles of its eyes, and peck. Helmholtz, however, is contending against the notion of pre-established harmony; and I am not aware of his views as to the organisation of experiences of race or breed.

manifestation of a power absolutely inscrutable to the intellect of man. As little in our day as in the days of Job can man by searching find this Power out. Considered fundamentally, it is by the operation of an insoluble mystery that life is evolved, species differentiated, and mind unfolded from their prepotent elements in the immeasurable past. There is, you will observe, no very rank materialism here.

The strength of the doctrine of evolution consists, not in an experimental demonstration (for the subject is hardly accessible to this mode of proof), but in its general harmony with the method of nature as hitherto known. From contrast, moreover, it derives enormous relative strength. On the one side we have a theory (if it could with any propriety be so called) derived, as were the theories referred to at the beginning of this address, not from the study of nature, but from the observations of men—a theory which converts the Power whose garment is seen in the visible universe into an artificer fashioned after the human model, and acting by broken efforts as man is seen to act. On the other side we have the conception that all we see around us, and all we feel within us—the phenomena of physical nature as well as those of the human mind—have their unsearchable roots in a cosmical life, if I dare apply the term, an infinitesimal span of which only is offered to the investigation of man. And even this span is only knowable in part. We can trace the development of a nervous system, and correlate with it the parallel phenomena of sensation and thought. We see with undoubting certainty that they go hand in hand. But we try to soar in a vacuum the moment we seek to comprehend the connection between them. An Archimedean fulcrum is here required which the human mind cannot command; and the effort to solve the problem, to borrow an illustration from an illustrious friend of mine, is like the effort of man trying to lift himself by his own waistband. All that has been here said is to be taken in connection with this fundamental truth. When "nascent senses" are spoken of, when "the differentiation of a tissue at first vaguely sensitive all over" is spoken of; and when these processes are associated with "the modification of an organism by its environment," the same parallelism, without contact, or even approach to contact, is implied. There is no fusion possible between the two classes of facts—no motor energy in the intellect of man to carry it without logical rupture from the one to the other.

Further, the doctrine of evolution derives man, in his totality, from the interaction of organism and environment through countless ages past. The human understanding, for example—that faculty which Mr. Spencer has turned so skilfully round upon its own antecedents—is itself a result of the play between organism and environment through cosmic ranges of time. Never surely did prescription plead so irresistible a claim. But then it

comes to pass that, over and above his understanding, there are many other things appertaining to man whose prescriptive rights are quite as strong as that of the understanding itself. It is a result, for example, of the play of organism and environment that sugar is sweet and that aloes are bitter, that the smell of henbane differs from the perfume of a rose. Such facts of consciousness (for which, by the way, no adequate reason has ever yet been rendered) are quite as old as the understanding itself; and many other things can boast an equally ancient origin. Mr. Spencer at one place refers to that most powerful of passions—the amatory passion—as one which, when it first occurs, is antecedent to all relative experience whatever; and we may pass its claim as being at least as ancient and as valid as that of the understanding itself. Then there are such things woven into the texture of men as the feeling of Awe, Reverence, Wonder—and not alone the sexual love just referred to, but the love of the beautiful, physical, and moral, in nature, poetry, and art. There is also that deep-set feeling which, since the earliest dawn of history, and probably for ages prior to all history, incorporated itself in the religions of the world. You who have escaped from these religions into the high-and-dry light of the understanding may deride them; but in so doing you deride accidents of form merely, and fail to touch the immovable basis of the religious sentiment in the emotional nature of man. To yield this sentiment reasonable satisfaction is the problem of problems at the present hour. And grotesque in relation to scientific culture as many of the religions of the world have been and are—dangerous, nay, destructive, to the dearest privileges of freemen as some of them undoubtedly have been, and would, if they could, be again—it will be wise to recognise them as the forms of a force, mischievous, if permitted to intrude on the region of knowledge, over which it holds no command, but capable of being guided by liberal thought to noble issues in the region of emotion, which is its proper sphere. It is vain to oppose this force with a view to its extirpation. What we should oppose, to the death if necessary, is every attempt to found upon this elemental bias of man's nature a system which should exercise despotic sway over his intellect. I do not fear any such consummation. Science has already to some extent leavened the world, and it will leaven it more and more. I should look upon the mild light of science breaking in upon the minds of the youth of Ireland, and strengthening gradually to the perfect day, as a surer check to any intellectual or spiritual tyranny which might threaten this island, than the laws of princes or the swords of emperors. Where is the cause of fear? We fought and won our battle even in the Middle Ages: why should we doubt the issue of a conflict now?

The impregnable position of science may be described in a few words. All religious theories, schemes, and systems which embrace notions of

cosmogony, or which otherwise reach into its domain, must, in so far as they do this, submit to the control of science, and relinquish all thought of controlling it. Acting otherwise proved disastrous in the past, and it is simply fatuous to-day. Every system which would escape the fate of an organism too rigid to adjust itself to its environment, must be plastic to the extent that the growth of knowledge demands. When this truth has been thoroughly taken in, rigidity will be relaxed, exclusiveness diminished, things now deemed essential will be dropped, and elements now rejected will be assimilated. The lifting of the life is the essential point; and as long as dogmatism, fanaticism, and intolerance are kept out, various modes of leverage may be employed to raise life to a higher level. Science itself not unfrequently derives motive power from an ultra-scientific source. Whewell speaks of enthusiasm of temper as a hindrance to science; but he means the enthusiasm of weak heads. There is a strong and resolute enthusiasm in which science finds an ally; and it is to the lowering of this fire, rather than to a diminution of intellectual insight, that the lessening productiveness of men of science in their mature years is to be ascribed. Mr. Buckle sought to detach intellectual achievement from moral force. He gravely erred; for without moral force to whip it into action, the achievements of the intellect would be poor indeed.

It has been said that science divorces itself from literature: the statement, like many others, arises from lack of knowledge. A glance at the less technical writings of its leaders—of its Helmholtz, its Huxley, and its Du Bois Reymond would show what breadth of literary culture they command. Where among modern writers can you find their superiors in clearness, and vigour of literary style? Science desires not isolation, but freely combines with every effort towards the bettering of man's estate. Single-handed, and supported not by outward sympathy, but by inward force, it has built at least one great wing of the many-mansioned home which man in his totality demands. And if rough walls and protruding rafter-ends indicate that on one side the edifice is still incomplete, it is only by wise combination of the parts required with those already irrevocably built that we can hope for completeness. There is no necessary incongruity between what has been accomplished and what remains to be done. The moral glow of Socrates, which we all feel by ignition, has in it nothing incompatible with the physics of Anaxagoras which he so much scorned, but which he would hardly scorn to-day. And here I am reminded of one amongst us, hoary, but still strong, whose prophet-voice some thirty years ago, far more than any other of this age, unlocked whatever of life and nobleness lay latent in its most gifted minds—one fit to stand besides Socrates or the Maccabean Eleazar, and to dare and suffer all that they suffered and dared—fit, as he once said of Fichte, "to have been the teacher of the Stoa, and to have

discoursed of Beauty and Virtue in the groves of Academe." With a capacity to grasp physical principles which his friend did not possess, and which even total lack of exercise has not been able to reduce to atrophy, it is the world's loss that he, in the vigour of his years, did not open his mind and sympathies to science, and make its conclusions a portion of his message to mankind. Marvellously endowed as he was—equally equipped on the side of the heart and of the understanding—he might have done much towards teaching us how to reconcile the claims of both, and to enable them in coming times to dwell together in unity of spirit and in the bond of peace.

And now the end is come. With more time, or greater strength and knowledge, what has been here said might have been better said, while worthy matters here omitted might have received fit expression. But there would have been no material deviation from the views set forth. As regards myself, they are not the growth of a day; and as regards you, I thought you ought to know the environment which, with or without your consent, is rapidly surrounding you, and in relation to which some adjustment on your part may be necessary. A hint of Hamlet's, however, teaches us all how the troubles of common life may be ended; and it is perfectly possible for you and me to purchase intellectual peace at the price of intellectual death. The world is not without refuges of this description; nor is it wanting in persons who seek their shelter and try to persuade others to do the same. I would exhort you to refuse such shelter, and to scorn such base repose—to accept, if the choice be forced upon you, commotion before stagnation, the leap of the torrent before the stillness of the swamp. In the one there is at all events life, and therefore hope; in the other none. I have touched on debatable questions, and led you over dangerous ground—and this partly with the view of telling you, and through you the world, that as regards these questions science claims unrestricted right of search. It is not to the point to say that the views of Lucretius and Bruno, of Darwin and Spencer, may be wrong. Here I should agree with you, deeming it indeed certain that these views will undergo modification. But the point is, that, whether right or wrong, we claim the freedom to discuss them. The ground which they cover is scientific ground; and the right claimed is one made good through tribulation and anguish, inflicted and endured in darker times than ours, but resulting in immortal victories which science has won for the human race. I would set forth equally the inexorable advance of man's understanding in the path of knowledge, and the unquenchable claims of his emotional nature which the understanding can never satisfy. The world embraces not only a Newton, but a Shakespeare—not only a Boyle, but a Raphael—not only a Kant, but a Beethoven—not only a Darwin, but a Carlyle. Not in each of these, but in all, is human nature whole. They

are not opposed, but supplementary—not mutually exclusive, but reconcilable. And if, still unsatisfied, the human mind, with the yearning of a pilgrim for his distant home, will turn to the mystery from which it has emerged, seeking so to fashion it as to give unity to thought and faith, so long as this is done, not only without intolerance or bigotry of any kind, but with the enlightened recognition that ultimate fixity of conception is here unattainable, and that each succeeding age must be held free to fashion the mystery in accordance with its own needs—then, in opposition to all the restrictions of materialism, I would affirm this to be a field for the noblest exercise of what, in contrast with the knowing faculties, may be called the creative faculties of man. Here, however, I must quit a theme too great for me to handle, but which will be handled by the loftiest minds ages after you and I, like streaks of morning cloud, shall have melted into the infinite azure of the past.

Correspondence.

MANURE EXPERIMENT IN ANTIGUA.

To the Editor of "The Sugar Cane."

Sir,

In reply to the two letters by Mr. J. B. Forster and a "West Indian Planter," in your last number, kindly allow me to state that the figures given are those of Mr. Sutherland, not mine; and, I take it that no one reading his remarks with care can fail to see that the yield from the Urban Cane Manure was 3 tons of sugar *per acre;* also, that in spite of the adverse season and taking into account the advantages of deep tilling, (which was rather hard upon the Urban Manure,) "the return from the Urban Manure has exceeded that from Peruvian guano by nearly half a hogshead *per acre.*" These are the words of the author of the report. As to the weighing of the canes that is *his* affair, I merely look to the yield of sugar from a given amount of special manure, and thus I consider the experiment a success.

I am, Sir,

Your obedient Servant,

T. L. Phipson, Ph.D., F.C.S.

London, 7th September, 1874.

CANE TRASHING.

As our readers are aware, cane trashing is the operation of stripping off the leaves from the plants as the canes are becoming ripe. In theory the dead leaves only are trashed, and piled in between the rows of cane; but in practice living leaves, or leaves that have not separated by natural decay completely from the canes, are torn off. It seems next to impossible to prevent this, and as the injury inflicted upon a cane by pulling off a single living leaf is sufficient to destroy—must destroy, in fact—a large proportion of the juices of the cane, carelessness in this work is a serious matter to the planter, and has tended in no inconsiderable degree to bring trashing into disrepute. We can believe—indeed know—cases in which the loss of sugar by trashing was greater than if the canes had not been trashed until they were cut and stripped for the mill. This was careless work, of course; slovenly practice, which is no rule for those who wish to do the best with their crop. But mishaps of the kind occur in spite of all the planter can do to prevent them, and he is a serious loser in consequence. But it does not follow that trashing is a useless operation. Upon rich, heavy soils, and in cases where the crop is heavy and backward, there is no mistaking the beneficial effects of trashing; but on lighter lands canes of the same kinds as those on the heavier soils, and planted about the same time, are generally freer from dead leaves, and the canes are riper and higher in density. In treating these two cases, as explained by several correspondents who have written on the subject, there is nothing for it but to rely upon the experience of others when the cane grower has not sufficient of his own to guide him.

From "Queenslander" of May 16, 1874.

SUGAR STATISTICS—GREAT BRITAIN.

To Sept. 19th, 1874 and 1873. In Thousands of Tons, to the nearest Thousand.

	STOCKS.		IMPORTS.		DELIVERIES.	
	1874.	1873.	1874.	1873.	1874.	1873.
London	99 ..	92	212 ..	194	192 ..	168
Liverpool ..	61 ..	64	132 ..	143	124 ..	110
Bristol	6 ..	7	62 ..	61	62 ..	59
Clyde	51 ..	66	138 ..	162	140 ..	145
Total ..	217	229	544	560	518	482
	Decrease..12.		Decrease..16.		Increase..36	

Stocks of Sugar in the Chief Markets of the World on the 1st August, for Three Years, in thousands of tons, to the nearest thousand.

	1874.	1873.	1872.
Great Britain	241	190	124
France	106	76	39
Holland	56	4	3
Germany (Zollverein)	5	59	36
Six other *entrepôts*	12	9	5
Total in Europe	420	338	207

Consumption of Sugar in Europe for Three Years, ending 1st August, in thousands of tons.

	1874.	1873.	1872.
Great Britain	833	661	689
France	243	381	273
Germany (Zollverein)	299	150	201
Holland	27	147	23
Six other *entrepôts*	112	63	89
Total in Europe	1,514	1,402	1,275

Estimated Crop of Beet Root Sugar on the Continent of Europe, for the ensuing Season, compared with that of the three previous Seasons.

(From Licht's Monthly Circular.)

	1874-75. Tons.	1873-74. Tons.	1872-73. Tons.	1871-72. Tons.
France	350,000	390,000	395,000	335,000
Germany (Zollverein)	250,000	287,500	260,000	189,000
Austro-Hungary	150,000	170,000	205,000	162,000
Russia and Poland	150,000	150,000	150,000	90,000
Belgium	50,000	70,000	80,000	72,000
Holland and other Countries	25,000	35,000	35,000	25,000
Total	975,000	1,102,500	1,125,000	873,000

STATE AND PROSPECTS OF THE SUGAR MARKET.

The sugar market for the past month has been marked by a very firm tone, and prices of raw have gradually and steadily advanced till they now stand fully eighteen pence higher than at the close of August. During the first fortnight this upward movement was not accompanied by a corresponding advance in the price of refined, and there appeared a probability of some portion of the demand from refiners being withdrawn, on account of the small margin left to them. At this time the enquiries in the raw market were chiefly, either purely speculative, or upon American account. Towards the middle of the month, however, there were indications of the refined market participating in the rise; refiners have now again come freely into the market as buyers, and consequently the end of the month witnesses a market well supported, and with a tendency still to favour sellers.

Viewing the causes of this advance in prices, the first that must be noticed is the unfavourable prospects of the beetroot crop, which, according to the latest reports, promises to be about one-fifth less than that made last season; upon the other hand, it is stated upon good authority that superior richness of the juice will go far to make up for this deficiency in the weight of crop. There is little doubt, however, that anticipations of a smaller out-turn of beet-sugar have formed the strongest basis of the late rise. Another cause which has also materially contributed to this result is the great scarcity of floating cargoes off the British coast.

With regard to the present statistical position, it is observable that the stock has now fallen to a point nine thousand tons below that of last year, that the imports up to date show a deficiency of seven thousand tons, whilst the deliveries are upon the increase being now 518,271 tons, against 481,728 tons this time last year This is a combination which points to a prospect of an active trade in sugar.

The latest quotations of standard qualities are as follows:— No. 12 Havana, afloat, 25s. 6d. to 26s., against 24s. 6d. to 25s.; fair to good refining Muscovadoes 23s. 6d. to 24s., against 22s. to 22s. 6d.; middling to good brown Bahia 20s. to 21s., against 18s. 6d. to 19s. 6d; common refined lump sugar 30s., against 29s. 6d. to 30s.

THE
SUGAR CANE.

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☞ The writers alone are responsible for their statements.

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TO OUR SUBSCRIBERS.

The change in the editorship of this magazine, occasioned by the ill-health of the late Editor of *The Sugar Cane*, and his inability in consequence to discharge the duties of editor, gives the proprietors the opportunity of saying a few words to the subscribers in reference to the objects of the magazine, and the best way of making it still more valuable to planters and others interested in the sugar industry. Although *The Sugar Cane* is especially devoted, as its name implies, to the interests of cane sugar planters, yet it would be a very imperfect advocate of those interests if it did not also give more than a passing attention to the great rival sugar industry which has made such great progress on the continent of Europe. There, owing to the practical application of chemical research to the manufacture of sugar from the beetroot, and also to fiscal arrangements which have hitherto protected that industry, a progress has been made in advance of cane culture which is startling, when compared with the comparatively stationary position of the latter industry. The causes of this success deserve the closest attention of cane sugar planters, and the adoption by them of such improvements as are applicable equally to their business; whilst the advocacy of true principles of trade to European fiscal exigencies is very important, in order that the natural and therefore the most profitable direction may be given to European agriculture by the removal of protective systems which give advantages, to the injury of the populations, to industries which otherwise could not

maintain themselves. To what extent science has made beetroot culture for sugar production a legitimate industry, and how much of its success is due to protection, are questions which must receive careful consideration in the future. That it is a protected industry we are well aware, though whether it would be able, if the protection it enjoys were removed, to compete with cane cultivation, is not so well understood. And there are two conditions of cane culture to take into account in considering the question: the present condition, and the possible conditions which the adoption of more scientific principles of manufacture would make more favourable to the sugar cane. The beet industry is carried on in the midst of European activity, and with scientific knowledge at its door, whilst the growth of the cane is conducted in countries far removed from these advantages, and in climates which temper energy and remove many incitements to inquiry and change. Cane sugar planting and manufacture is very widely scattered over the world's surface, and conducted in countries which are only just coming under the influences of civilisation and new populations. It is clear, then, that anything which will concentrate the interest of planters, and to some extent compensate for the disadvantages of isolation, will be valuable and just to the extent it serves this purpose. In the past numbers of *The Sugar Cane* there is gathered together more information from various parts of the world than had previously been collected in any English work treating on the cultivation of the sugar cane. But it is possible to increase this store and the usefulness of the magazine, if all those who are interested and actively engaged in the industry would make more use of its pages in exchanging their experiences in cane cultivation and the manufacture of sugar from the juice, either by giving information likely to prove serviceable, or in inquiring for the solution of difficulties which may present themselves, from others who have successfully coped with them. The large quantities of dark spoilt cane sugar which pour into England from many quarters is fast becoming an anachronism in a manufacture which, when it is applied to the beetroot, produces the beautiful results which are a striking contrast to these crude productions from the cane; and it is certain

that a great change must take place if the cultivation of the sugar cane, in many places, is to be successful.

Whether this change will be in the adoption of refining in tropical countries, or of rapid and inexpensive processes for conversion of the cane juice uninjured into a form best suited for long sea voyages to markets where the refining can be done more cheaply, and with less risk of injury to the delicate product in its passage to the consumer, are questions which are already debated. But there can be no doubt that the rude method of concentration by open batteries must give place to something more in conformity with our present knowledge, and they who are the first to adopt the soundest principles will reap the advantages of their foresight, and avoid certain disappointment.

We are apt to lose sight of the advance which is made beyond us when we do not practically come into contact with our rivals. We put up with old and bad methods of manufacture, when a knowledge of better ones would convince us of the necessity of improvement; and to no industry are these remarks more applicable than they are to cane sugar planters in many parts of the world. One of the chief objects of *The Sugar Cane* is to enable planters to profit by such knowledge, and by a closer intercourse with each other; but this can only be effected by their co-operation with the editor; and the ablest planters, by making the columns of *The Sugar Cane* a medium for the enlightenment of their co-workers in other parts of the world, will themselves be served even more than they serve, by the practical assistance they will afford in making the magazine worthy of representing the important and interesting industry in which they are engaged, and capable of effecting the service we have indicated.

The Sugar Cane ought to be received regularly by the first mails leaving England on and after the first of each month. If any of our subscribers do not receive their numbers regularly, we shall feel obliged by their notifying the same to the editor, so that inquiries as to the cause of any irregularity may be instituted. The postage thus incurred will be placed to the credit of their subscriptions to the magazine.

REFINING IN BOND IN FRANCE.

There appears to be some prospect of the adoption of refining in bond in France at an early date, owing to the pressure brought to bear by the present Government, through Lord Derby, on the French Government. The Duc Decazes has promised Lord Lyons to communicate to the English Government, early in October, the code of regulations considered by the French Government necessary for the supervision of its refineries, stating at the same time that it was the desire and determination of the French Government to establish refining in bond as soon as possible.

LECTURE ON THE CULTURE OF BEETROOT.

By M. Georges Ville, of Vincennes.

(Given at Brussels, before the Central Society of Agriculture of Belgium.)

[Translated from the French.]

Except for the importance of the following lecture, we might have hesitated in giving it so large a space in our magazine. M. Georges Ville has devoted many years to experiments in the cultivation of the sugar beet, and has succeeded, by the methods he describes, in nearly doubling its saccharine richness. One of the means of his success appears to be equally applicable to the culture of the cane—viz., the composition of the manures, of which he has supplied the formulas. Whether the careful selection of canes for new planting is likely to be followed by improvements as important as in the case of the beet may be matter of doubt, but it seems to us to be one of the things which the sugar planter should give his attention to.

We need offer no apology to the chemical manure manufacturers of our country for submitting M. G. Ville's formulas to our readers. It is to their interest, as well as that of the planters, that they should have the best information we can give them; and it by no means follows that they may not still further improve upon M.

Ville's discoveries, or that even now they may not have evidence of results from their own manufactures as satisfactory as those to which that gentleman has directed attention. We shall always be glad to hear of, and publish their successes.

Mr. PRESIDENT,

In making my appearance among you, I have yielded to a sentiment which, with me, overrules every other. Your Society has done me the honour of naming me an honourable member; and I have come to thank you, animated by a feeling of gratitude which made me eagerly avail myself of the opportunity of expressing it.

Permit me, Mr. President, to perform this first duty. I do not know exactly what you expect from me, and have come without any preparation.

The question of chemical manures is claiming the attention of all countries, and you are, perhaps, desirous of hearing what my thoughts on the subject are. Some persons are its fanatical partisans, and, like all fanatics, they often injure the cause to which they are devoted. Others condemn it because they do not know it, or know it imperfectly.

It might, therefore, perhaps, be useful to treat of the doctrine of chemical manures from a general point of view, to present it to you in its strictest sense, to show how it is connected with the past of agricultural practice, and continued by tradition; or since you are all interested in the question of beet culture, it might be preferred that I should speak to-day on that question only, and endeavour to show how far we have succeeded in it. If I have rightly comprehended the thought which animates you all, and the desire which has been expressed to me, it is to the last subject you would prefer I should confine myself.

If we wished to consider the question of chemical manure in all its aspects, we should have to devote much time to it; and if you were prepared with objections which, for my part, I always desire to hear, it would be necessary that I should reply to them, which would lead us into a lengthened discussion; and the important interest which perhaps chiefly occupies your minds—the beet cultivation—would not be satisfied.

I have come here to thank you, gentlemen, and am ready to comply with your desires. I have no personal preference. I come to reply, to the best of my ability, to the kind wishes you have conveyed to me. If you desire that, confining myself within the domain of practical interests, I should begin with what I am best acquainted with in connection with beetroot culture, I will do so with pleasure, or if you wish that, having made each other's acquaintance, we should defer to another day the business of discussing, generally, the doctrine of chemical manures, we will consider to-day's sitting simply as an introduction.

Well, gentlemen, concerning beetroot, what do we know, what do we not know, and what is it our interest to know? I cannot but repeat to you what I said this morning to one of your vice-presidents: In one respect I have been very fortunate, in another I have still much to do.

I have positive results which I can answer for—results which are useful, certain, and very important in an economical point; but there are some theoretical questions which embarrass me—questions upon which I am still hesitating, seriously embarrassed. If I wished to submit to you now an unassailable theory, I would not speak of the researches which I have been pursuing for eight or ten years with a veritable passion. If I thought only of myself, I would pass, in silence, researches which are within your own reach, and wait; but I do not trouble myself concerning what theory, in its inexorable demands, may dictate. My ambition is to do a little good, and I endeavour never to fail in this duty.

In the beetroot question there are two interests equally important which we should apply ourselves to conciliate—the interest of the agriculturist and the interest of the sugar industry. To sacrifice one of those interests to that of the other would not only be unjust, but render any lasting solution impossible.

The agricultural interest requires large crops. Below 30 to 35,000 kilogrammes per hectare, the cultivation of the beet is not remunerative. The second interest, that of the sugar maker, is equally imperious. He must have roots which contain not less than 12 per cent. of sugar. Below that, the return at the factory

is hardly 4 per cent., and at that rate there is no profit. It is evident that he who converts the root must extract from it as much sugar as will leave a profit on his labour. If this result is not attained the factory he has built at a great cost cannot be carried on. Its stoppage is inevitable, and, as a consequence, the cultivator, who should supply it, loses his market.

On the other hand, if the cultivator, to obtain roots of good quality—of the superior quality, which the sugar industry requires—must so far sacrifice the yield, and grow roots so small that in the end he gains nothing, he has no inducement to take them to the factory.

In order to conciliate these two interests, it is necessary to arrive at an understanding on a principle of equity. Instead of each trying to gain an advantage for himself only, they ought to define the problem scientifically, and say: We make a bargain in the interest of both, by which both can and ought to be gainers.

Impressed with these ideas I have arrived, by experience—a persevering and rigorous experience—at this result. I have obtained beetroots of a high saccharine standard, of which the return in weight is also very good. The theory of this result I only partly understand, but along with the theory I have fact, and this fact I have now to communicate to you. If any among you, gentlemen, can help to complete the theory, I shall be the happier of the two. If he favours me with observations that will enable me the sooner to gain that end I will still thank him. If he raises objections which I cannot answer, I must console myself as best I can. I do not pretend to offer you what I do not possess. I simply lay before you the positive results at which I have arrived.

I enter, then, without further preamble, into the heart of the question.

To obtain heavy crops of beetroots, what is needed? In the first place, manure containing a large quantity of azoted matter: this is an indispensable condition. Please to note, gentlemen, that I pass over the doctrine of chemical manures. If I was to enter into an explanation of that doctrine we should lose sight of the

beet. I shall conclude that you are already acquainted with all the general ideas in relation to it, and continue.

In regard to azoted matter, there are two points to consider. Azoted matter is either immediately assimilable, because it is soluble; or else it is in the condition of animal matter which is not immediately assimilable, and which requires to be decomposed to produce all its useful effects.

In the first case, we obtain roots of superior quality, and in the second, such as are generally poor in sugar.

To obtain a large crop of roots, we must use about 80 kilogrammes of azote immediately assimilable. If, instead of that, we give the land 200 kilogrammes of azote in the state of farm yard manure, Flemish manure, or cake,—that azote, which is insoluble, and part of which only acts slowly on the root, has the inconvenience of continuing its action after the plant has reached the term of its development; and by forcing, at the last hour, the production of fresh leaves—in place of enriching the root, it takes from it a part of the sugar which it contained, and makes it poor. I repeat, that if the root is stimulated to push out leaves at the latter end of the season, the sugar disappears.

Consequently, the first result for which we are indebted to experience: *To have a large yield of beetroot, we must make a liberal application of azoted matter and, if they are to be of good quality, it must be applied in a soluble form.* The root absorbs it in six or eight weeks before the term of its development, and we avoid, at the latter part of the season, the formation of new leaves which, in place of enriching the root, takes from it part of the sugar it contained.

Remark, gentlemen, that this is not all theory. No, I am now simply within the region of facts. I will also add, in order to complete this first indication,—use chemical manures in preference for beetroots; and, for azoted substances, the nitrate of potash, the nitrate of soda, or the sulphate of ammonia, the effects of which may be regulated at pleasure, because they are entirely soluble; and when you must have recourse to farm yard manure, do not exceed, if you can help it, more than 20,000 kilogrammes

per hectare, dug, or ploughed in, in the autumn, and add, as a complement, a dressing of chemical manure in the spring.

I shall repeat, therefore, once again,—a considerable quantity of azote must be used for beet, if you are to have roots of good quality. It is necessary, moreover, that the azote should be absorbed six or eight weeks before the term of the active period of growth, that the root at the time of gathering should be in that special physiological state which has acquired its complete development, when the leaves wither without a second vegetation.

The nature of the manure, the reciprocal relation of the elements which compose it, and their degree of solubility, have therefore a considerable influence at once on the weight of the crop and the saccharine richness of the roots.

When I commenced my experiments at Vincennes, the ground on which the plot was laid out was a newly ploughed up meadow. The first year I obtained a beautiful crop of roots, but they only produced on an average from 8 to 9 per cent. of sugar.

In the succeeding years the yield has been maintained at between 35 to 50,000 kilogrammes per hectare, but the quality has undergone a progressive improvement which has not yet been arrested, inasmuch as to-day my roots turn out on an average from 14 to 18 per cent. of sugar.

There (pointing to the root) is a root weighing 1,000 grammes, which contains 14 per cent. of sugar. Here is another which weighed 1,200 grammes, and contains 12·5 per cent. of sugar; but it is now the 9th of March. Those whose weight are less than 1,000 grammes will contain from 16 to 18 per cent.

Is this result exceptional? Far from it: it is a general fact. All sugar makers who look narrowly after their business know that, with chemical manures, the roots excel in richness those grown with farm yard manure.

I give you one testimony among many others, the value of which is enhanced by the position of the distinguished man from whom I received it.

M. Caillet, civil engineer, one of the directors of Fives-Lille, has obtained, with chemical manures, on a farm in Normandy,

beetroots which contained 15 per cent. of sugar, when with farm-yard manure the standard did not exceed 10 to 11 per cent. The trials were made in the years 1871-72.

I received, about a week ago, from a learned and very estimable gentleman, M. Pagnoul, professor of chemistry at Arras, this pamphlet, in which he gives an account of experiments in cultivation made, side by side, with chemical, and farm-yard manures. Here we have all clear, precise, and of easy comparison.

On the one side, the action of farm-yard manure, which contains 200 kilogrammes of azote in an insoluble state, by its slow but continuous decomposition of the substances which contain it, is prolonged to the end of the plant's growth. On the other side, on the contrary, chemical manures which are capable of immediate absorption act powerfully at the beginning, and very feebly at the end.

What was the result of this experiment? In all respects excellent. With farm-yard manures, roots containing 9 per cent. of sugar were obtained. With chemical manures they reached 14 per cent. (13·7). You will further remark, gentlemen, it is not I who speak, but practice pursued for its own sake.

I will not trouble you with the observations of M. Pagnoul, who is a learned man by profession, whose testimony is enhanced by the practical centre in which he lives, and the interests which his position calls upon him to enlighten and serve.

Thus two orders of facts establish the superiority of chemical manures for the cultivation of beet. On one side, practical field experiments at Vincennes, which embrace a period of fourteen years; on the other, the testimony of *le grande culture*, which, whilst generalising, registers the results it has obtained.

Let us pursue the question a little more closely. What is, exactly, the increase of richness which can be produced by the choice of manures, and the just balancing of the substances which compose them?

I do not think it less than 3 or 4 per cent. of the weight of the roots. For a crop of 40,000 kilos., an increase in richness of 3 per cent. makes a total of 1,200 kilos. of sugar, worth from 6 to 7,000

francs. If only one-half or a third of this excess can be utilised at the factory, the result will still be very good. But this is not all. Does the choice of manure exhaust our means of action? We have within reach another means, not less efficacious than the first, confirmed also by practice. It is the choice of seed.

M. Vilmorin, who has made very valuable researches over a long period, with a view to the improvement of the vegetable races, has, by the selection of seed, succeeded in producing roots which give a sugar standard of 14, 15, 16 and 18 per cent. But these roots, so rich in sugar, have one disadvantage. The crops are but light, and the roots, besides, are forked; that is to say, the extremities terminate in four or five independent roots, which hold much soil. These forked roots give so much trouble in washing at the factories, that the sugar makers, in spite of their exceptional richness, are unwilling to buy them. And then, again, the farmer has no interest in producing such roots, on account of the smallness of the yield, which scarcely exceeds 25,000 kilogrammes per hectare, if even they reach as much. Let us suppose that upon a hectare you obtain 20,000 kilogrammes of these roots. That, at the rate of 20 francs, makes 400fr. If you have spent 400 francs in manure, you have nothing left.

But, they say, the corn which succeeds the beet is the real source of profit. To ascertain this, we must carry over a part of the cost of the manure to the second year's crop. This amendment, if acknowledged, does not remedy the difficulty, and we are not willing to admit it to the title of a solution. If the quality of the root is only obtained at the price of a crop which is insufficient to be remunerative, there is one interest injured, viz., that of the farmer. Now, if there is an interest which I would never consent to sacrifice, it is that one. It is therefore necessary we should succeed in obtaining a yield of 40,000 to 45,000 kilogrammes of rich roots, so as to be able to say to the sugar maker: These which we bring you are perfect, the form is unexceptionable; they contain 15 per cent of sugar. Henceforth, you must pay us their real value.

In these conditions, the sugar maker will make his bargain and

you yours. The two interests must be considered, or the solution will be incomplete.

Let us, therefore, now see what must be done for the improvement of the root to complete the effect produced by the manures. It is necessary, in the first place, to select well-shaped roots and to reject irregular ones—to reject both those which are too large and those which are too small. Those which weigh between 1,000 and 1,500 grammes are to be preferred.

This first selection being made, we should analyse, one by one, each root. For that purpose we scoop out, with the aid of a steel taster, a piece of about 20 to 30 grammes, about a third of the distance from the neck. The zone at that part contains the average richness of the entire root. The pods of a root yielding less than 13 to 14 per cent. of sugar should not be saved for seed.

The small wound which the roots receive will neither injure their good keeping qualities, nor the production of seed; but it is necessary to keep them in well-ventilated pits, and above all, to guard against desiccation.

The seed thus obtained is used for the production of one crop from which a new selection is made, but this time from roots of the required size and form. The seed from this second generation is to be that on which we are afterwards to depend.

You always confine yourselves to the use of the same seed: now, in proportion as the generations succeed each other the weight of the root diminishes. That which had at first so perfect a form changes, and becomes forked, and the return becomes less. You begun well in selecting a rich beetroot, which, at first, produced seed of good quality; but the variety which you initiated alters, and little by little the advantage it gave you diminishes and becomes extinct. You thus find yourself where you were at first. But there is a means of obviating this disadvantage; and this is, never to stop in your selections.

I therefore ask again: Do you want roots of superior quality? The condition is absolute. You must renew every second year the selection of seed pods as the stock of a new race. On this condition alone is the weight, the form, and richness maintained at the desired standard.

Allow me further to repeat :—When the time of gathering has arrived, choose the roots one by one, class them according to their degree of richness, eliminate all defective forms, all of insufficient size; avoid poor roots, and only save the pods of those which, in point of form, leave nothing to be desired—of which the superior richness and weight are sufficient. The seeds from those roots will serve for the production of a new crop, and may be given with perfect assurance to those who cultivate for the factory. But the year following it will be necessary to reproduce new seed, and always regenerate it by eliminating all badly-formed plants and all poor roots. This labour of selection has for its object the continual renewing of the seed.

Proceeding in this manner we arrive at excellent results. There you have specimens of roots which I obtain regularly. I renew my seed every second year, and have a nursery for that purpose, on which I exercise the most active supervision.

Here a very important practical question presents itself. Is such a work of selection within the reach of agriculturists? Is it reconcilable with all the cares and variety of labour which is comprised in the management of a farm? I do not hesitate to say—No. In order that the result may be adequate to the cost, that the means which I point out may give all their results, it is necessary that the raising of the seed should be the business of the sugar maker, who is primarily interested.

For that, what is needed? To annex to each factory ten or twelve hectares of land for the purpose of experimenting and continually improving the formula of the manures, and providing seed for those who supply it with roots. To these measures add the proscription of animal matters as manures, or at least reject their use except in moderate quantities; and you will witness, to the common satisfaction of the industry and the cultivator, that reconciliation of interests which has been the object of my efforts for more than ten years.

Do you wish that I should state, in a practical and financial point of view, precisely what can be accomplished by these measures? If you listen to the manufacturers they tell you they

draw almost nothing from the beetroot. If they are moved from the side of an exhibition of skill, they will perhaps affirm that they get 6 to 7 per cent. of sugar. The truth is, that when they obtain, in the working, 5 per cent. of sugar from the root, the result is satisfactory. Let us, then, take a factory which requires for its supply the growth of 1000 hectares of land. This is, at present, about the requirements of the existing factories. Very well, I now proceed to make very modest, very practical, and very moderate suppositions. For roots with a standard of 10 per cent. of sugar, giving 5 per cent. to the factory, let us substitute such as contain 12 to 13 per cent., and yielding 6 per cent. at the factory—an improvement of 1 per cent.; and for a crop of 40,000 kilogrammes we have an excess of 400 kilogrammes of sugar per cultivated hectare, of the value of 200 to 240 francs; and for the 1,000 hectares, which is the requirement of the factory, an excess of production worth 200,000 to 240,000 francs, which the manufacturer legitimately puts in his pocket; and it is just that he should do so, as he has drawn them from the root. But is it not likewise equitable that the agriculturist, who has caused this added increase in value, should share in the result?

A new question. You know that manufacturers say: If you bring us rich roots we will pay you well. But how is this richness to be ascertained? Must all the roots be analysed? In matters of this kind discussions without end arise, which is almost always the case when one begins from pure theory to regulate practical interests. Belgium is renowned for its great industrial capacity. You have, among your many other qualities, that of being essentially practical. Here, then, is the expedient which I propose to you. Take a crop produced in the conditions I have indicated—that is to say, from renovated seed and well-proportioned manure. If in analysing a certain number of roots you find that commencing from 600 grams., and rising to 1,500, the richness is maintained, but sensibly diminishes beyond that weight, this is a point ascertained of great importance, for it furnishes an equitable base between the producer and manufacturer. This base is in the mean weight of the roots. The manufacturer will object to roots

which are too large, and demand a reduction in price, because, in the generality of cases, the roots which exceed 1500 grams. are less rich. It is but just that these roots, the weight of which compensates for the want of richness, should be paid for at a lower price. If you furnish to the agriculturist a seed produced from a continuous and permanent selection, and the agriculturist, on the other part, who is interested in raising a good crop, has carefully followed the instructions I have formulated, and will complete, as briefly as possible, with a sketch on the composition of the manures, you are sure, by eliminating the roots whose weight exceeds 1500 grams:, of obtaining 40 to 45,000 kilogrammes to the hectare of very rich roots. The two interests are thus reconciled, and misunderstandings rendered impossible.

This year an innovation will be commenced in France, of which I have taken the initiative, and which I should like to see imitated in Belgium.

I have told a certain number of sugar makers, described to me as the highest authorities, in the estimation of their colleagues, of this great and excellent industry, who solicited my advice, under pressure of the recent unfavourable season: Leave me to substitute my personality for yours; delegate your powers to me; give me ten hectares of land. I will put it under cultivation according to my own ideas. In that matter I will be your dictator, for if liberty is a holy thing, dictation is not always a bad one. Your beetroot purveyors arrive. They see what is being done. There is no mystery. We act in broad day light. They can even, if they wish it, be present at the ingatherings of the crops, and prove for themselves what excellent products we obtain. The interest of the agriculturist will be thus protected. Moreover, I say to the manufacturer: You, even you, must be satisfied, because the roots I have produced are exceptionally rich. I propose to annex to each of your factories a laboratory for analysis and selection. I propose to make 6, 7, 8, 10,000 analyses, and class the roots according to the degree of richness and perfection of form. We will eliminate all that are bad. Then, having obtained these beautiful specimens of roots, we proceed to the production of

excellent seed. There is no mystery in all this. We wish to deceive nobody. Our object is the conciliation of two interests equally legitimate. When we give the cultivator a seed produced under his own eyes, from roots which insure a large and very remunerative return, alike for him and for the manufacturer, there is no room for either to complain.

I repeat to you, gentlemen, that I am at the present time making arrangements for carrying this plan into operation. I shall be happy if the Central Society of Agriculture, or some of its members, will have the goodness to adopt this method, and not hold back because of complications which are more apparent than real. The great principle is in the selection of seed. The rest follows as a consequence. A problem well stated is half solved.

Are you frightened at the obligation of making 6,000 or 7,000 analyses? It is but play. Children of ten or twelve years of age are capable of doing this work with unimaginable rapidity. You must understand that an academical education is not needed. I would not by any means propose so foolish a thing. But if an analysis informs me that in a root there is 14, 14·5, or 15 per cent. of sugar, I have no need to trouble myself with all the niceties which science demands, or which theory requires from him who wishes to formulate laws, on the condition well understood, that I am satisfied, from an industrial point of view, that the quota of 14 per cent. is within a fraction more or less exact. What does good sense desire? A just relation between the end proposed and the means used for its attainment. What do we desire? That the industry may have roots containing 14 to 17 per cent. Let us arrive at that result, and critical subtlety, should it be attempted, will find nothing to quarrel with.

Well, gentlemen, that is the way we ought to go to work. Let us not recoil before difficulties. The important thing, I repeat, is selection. We must every year make our seed ready for the next, preserve purity of form, assure ourselves of the required degree of richness, proscribe strong applications of azote in the shape of animal matter; provide against the disturbing causes, the dangers of which I have pointed out, which are attested by the practice of

all the departments where oil-cake, Flemish manures, and animal matter are used in excess.

I now arrive at the most delicate side of the question, not indeed in a practical, but a theoretical point of view.

What is the manure which is best suited to the beet? When we touch upon questions of manure we should be prepared to meet two cases. And if there is so much discussion, if the subject is so eagerly seized upon from opposite sides, it is because instead of looking at things as they are, each looks from his own point of view, to impose or combat an opinion which he is unwilling to accept.

I say that in the matter of manure we have two very different cases to consider: that where chemical manures only are used, and that where they are used in conjunction with farm-yard manure or other animal matter.

When I began my studies on vegetation I used chemical manures alone; but in doing so I had not the least thought in the world of prescribing their exclusive use.

From a scientific point of view, and the obligations of teaching with which I was charged, what was the duty imposed upon me? To ascertain the properties of all agents, near or remote, which contribute to the production of vegetables. Now, to attain this end there was but one method—only one: to employ manures, the ingredients of which are uniformly found in their constitution and exactly determined by their nature, which, in varying their quantities and in changing their mode of combination, could alone enable me to record the observed effects of every unknown element. If I had introduced into manure substances variable or indeterminate in their composition—animal matter, for example—the action of these matters changing according to the facility with which they entered into decomposition, what conclusion should I have been able to deduce, when we know that during the work of decomposition which precedes the useful effect, a variable part of the azote is lost to the plants? On the contrary, if you employ the sulphate of ammonia, the nitrate of potash, or the nitrate of soda—except as they are soluble, and immediately assimilable by

the plants—those substances having an invariable composition, and properties which are not less so, all becomes relatively simple and easy to define. In fixing my point of departure in the exclusive use of chemical manures, I was forced to it by the nature and necessities of the object which I had placed before me.

Faithful, from this point of view, in some sort ideal, the only one calculated to afford us positive indications respecting the requirements of different plants, and which has so much the greater value to-day, because practice, superseding theoretical prescriptions, has demonstrated that cultivation by chemical manures alone is becoming a fact more and more generally known, let us inquire what ought to be the composition of manure for the sugar beet.

Here we have it:—

Superphosphate of lime....	400	kilogrammes	to the hectare.
Nitrate of potash	200	,,	,,
Nitrate of soda	400	,,	,,
Sulphate of lime	300	,,	,,

The quantity of azote which corresponds to this formula is about 85 kilogrammes. This manure is excellent.

We read in all treatises on industrial chemistry that certain salts injure the quality of the beet, and, notably, alkaline chloride. You understand, gentlemen, that when we seek to test a theory of vegetable production by a multitude of experiments, in conditions the most varied, in artificial soils formed of calcined sand, and on poor land, as I have done at Vincennes, we must, for a time, admit certain opinions which pass in science for demonstrated truths.

Chlorides being reputed injurious, I commenced by proscribing them from my formulas of manure. It was a concession to prevailing ideas. But earthquakes occurred in Peru. The stock of nitrates was destroyed. The price rose beyond measure. That of nitrate of potash, notably, advanced from 65 to 80 francs, and even 90 francs the 100 kilogrammes.

To escape this rise in price, the idea occurred to me to try afresh the use of chloride of potassium in the manures. A first applica-

tion astonished me. Scheele and Berthelet have acknowledged that alkaline chlorides, mixed with carbonate of lime, in a porous medium, is decomposed and passes into the condition of carbonate. It was also, relying on this reaction, that Berthelet explained the formation of natron in certain lakes in lower Egypt.

Absorbed in these experiments, I then tried, side by side with the manure of which I have given the formula, some with chloride of potassium, and notably the following:—

Superphosphate of lime....	400	kilogrammes	to the hectare.
Chloride of potassium	200	,,	,,
Sulphate of ammonia	200	,,	,,
Nitrate of soda	300	,,	,,
Sulphate of lime	200	,,	,,

Like the first, this manure contained 85 kilogrammes of azote.

But here it is necessary to make a reservation. When the beet is grown too often on the same land, and the crops thereby become uncertain, precarious, and the roots of bad quality, this manuring is insufficient. The deep beds of the soil have been injured, and demand a remedy.

In such a case it is necessary to increase the application of the manure by one-half, and divide it into two parts; one for the deep beds, dug in by special labour, the other being reserved for the surface in the ordinary manner.

For the deep beds.

Superphosphate of lime....	200	kilogrammes	to the hectare.
Chloride of potassium, at 80°	200	,,	,,
Sulphate of ammonia.....	100	,,	,,
Nitrate of soda	100	,,	,,
Sulphate of lime	200	,,	,,

For the surface.

Superphosphate of lime....	400	kilogrammes	to the hectare.
Chloride of potassium, at 80°	200	,,	,,
Sulphate of ammonia.....	200	,,	,,
Nitrate of soda	300	,,	,,
Sulphate of lime.....	200	,,	,,

The two manures united represent an expense of 400 to 500

francs. But the year following, with 100 or 150 kilogrammes of ammonia we get a return of 30 or 40 hectolitres of wheat.

By introducing chloride of potassium into the manures for beet-root, "*I was the man who seeks,*" and I was, in truth, happily inspired on the day in which I came to that decision, for, by mixing the manure with chloride of potassium I obtained roots of the highest standard for sugar.

And that was not all. What was my surprise when, pursuing the question still closer, I ascertained that in proportion as the richness increases the salts diminish.

In proportion as we improve the race—in proportion as we perfect the manures, the salts disappear. What remains at last is but an insignificant quantity.

On this subject I will relate to you a little incident which is not wanting in interest. I am very fond when I state a thesis—to which, for greater clearness, I often give a somewhat absolute form—I am very fond of having proofs at hand for forestalling criticism. I take care to substitute proofs, in the place of affirmations, which my correspondents or my friends supply me with, even unknown to themselves. Last year, M. Pagnoul, whose excellent remarks on the unfavourable effects of farm-yard manure I have referred to, wrote me: "Where are you in your researches on the beetroot subject, and what results have you arrived at?"

M. Pagnoul was led to put this question to me because the *Société d'Agriculture d'Arras* had asked me, in 1868, to give a lecture on beetroot, and I had related, on that occasion, the result of a very decisive experiment made in Belgium, with M. Verlat-Carlier, upon land which refused to grow beet, and on which I succeeded in producing them at the rate of 40,000 kilogrammes per hectare, with a standard of 13 per cent. of sugar. I then indicated, rather timidly and in a less affirmative form, facts which I have to-day presented to you more completely.

Instead of replying to M. Pagnoul's question as to where I was, I sent him three hampers of roots, saying to him: "Examine for yourself. Estimate the salts, estimate the sugar, satisfy yourself as to the quality. Can you produce roots like these from the reputedly

most skilful cultivators? Analyse and form your own conclusions."

What was the result of that comparative study to which M. Pagnoul consented to apply himself? This little table will inform you better than long explanations:—

Beetroots of the locality.

	Weight.	Sugar per cent.
No. 1	3,977 grams.	7·3
,, 2	1,500 ,, ...	9·2
,, 3	1,240 ,, ...	8·0
,, 4	1,197 ,, ...	8·8
,, 5	1,195 ,, ...	6·0
,, 6	804 ,, ...	6·6
,, 7	758 ,, ...	8·8

Average: 7·8 per cent of sugar.

Beetroots from the field of experiments at Vincennes.

Lot 1.

	Weight.	Per centage of Sugar.
No. 1	1,629 grams.	10·1
,, 2	1,354 ,, ...	11·9
,, 3	1,107	14·3
,, 4	702 ,, ...	15·2
,, 5	552 ,, ...	15·0

Average: 13·3 per cent. of sugar.

Lot 2.

No. 1	1,705 grams.	11·4
,, 2	1,288 ,, ...	16·4
,, 3	1,129 ,, ...	16·3
,, 4	798 ,, ...	15·3
,, 5	309 ,, ...	17·9

Average: 15·4 per cent. of sugar.

Lot 3.

No. 1	1,803 grams.	12·5
,, 2	1,121 ,, ...	13·8
,, 3	685 ,, ...	15·4
,, 4	612 ,, ...	17·2

Average: 14·5 per cent of sugar.

We may add, as a last observation, that these standards were taken in the month of January, when the roots begin to lose a part of their richness.

I have told you there is a point at which the soluble salts diminish as the roots improve. Judge yet again by these examples:—

Beetroots of the locality.

	Salts per cent. of Sugar.
No. 1	11·6
,, 2	9·6
,, 3	11·5
,, 4	10·8
,, 5	21·8
,, 6	19·6
,, 7	10·8

Average: 13·6 of salts per cent. of sugar.

Beetroots from the field of experiments.

Lot 3.

No. 1	4·3
,, 2	3·3
,, 3	1·3
,, 4	1·4

Average: 13·6 per cent. of salts.

In short, the average of all the results may be stated as follows, under the double relation of sugar and salts.

		Sugar per cent. of the root.	Salts per cent. of sugar.
Beetroots of Vincennes.	Lot 1	13·3	3·9
	,, 2	15·4	3·6
	,, 3	14·5	2·6
Roots of the Industry		7·8	17·6

My experiments this year at Vincennes have permitted me to push still further the verification of the relation of dependency which exists between richness in sugar and poverty in salts.

One can nearly judge of the richness of beetroots in sugar by the quantity of ashes which they leave after combustion.

These are some examples, classed according to richness in sugar:—

Sugar per cent. in fresh roots.	Ashes per cent. in dried roots.
20 per cent.	2·8
15 ,, ...	3·6
10 ,, ...	5·1
5 ,, ...	10·0

We will now return to manures. From the excellent results which manures with chloride of potassium have given me, under the double relation of weight of crop and richness of roots, does it follow that I condemn manures of which nitrate of potash form a part? Nothing would be further from my thoughts. These manures themselves are excellent.

It was only with extreme caution that I introduced into practice manures with chloride of potassium; but I am obliged to place them very high, since experiments have so pronounced.

As a general thing, I only propose new formulas of manures with extreme circumspection. I try them for several years before introducing them to the public, whereby I have the satisfaction of first seeing them proved by practice.

At the present time, in the department of the Nord, two extremely dangerous practices prevail. They misuse sulphate of ammonia and nitrate of soda by applying them by themselves. It is certain that eight times out of ten they will obtain by their aid a largely increased return, but to the prejudice of quality and maintenance of the fertility of the soil—a double fault, against which I wish to guard you.

Permit me, gentlemen, to sum up and conclude.

My ideas comprise four propositions, which I have now laid before you. Let us briefly recall them.

1st. Avoid the use of animal matters, or, at least, use them in very moderate quantities, and then in conjunction with chemical manures.

2nd. With chemical manures alone, beetroots are richer than with farm-yard manures. When chemical manures are used, they should be in such proportions as to give 80 to 85 kilogrammes of azote to the hectare.

3rd. If you wish to use farm-yard in conjunction with chemical

manures, do not exceed 20,000 kilogrammes per hectare, spread over in the autumn and buried deep in the soil. Then spread as a covering, in spring, 800 kilogrammes of one of the two chemical manures I have mentioned, harrowing it well into the soil before sowing.

4th. Give particular attention to the production of the seed. Reject inflexibly, all seeds which are grown on roots which are badly formed or too large, and generally all such as contain less than 14 per cent. of sugar. Renew the seed every two years.

The observation of these four rules will procure you returns of 40 to 45,000 kilogrammes per hectare, containing on an average 14 to 15 per cent of sugar.

Then that conciliation, so desirable between the industry and the agriculturist which I spoke of at the commencement, will be arrived at, by the combined means of science and equity, which ought to turn to the profit of both. To what purpose are costly factories to be erected, with the most perfect machinery, if the roots supplied to him are of bad quality.

If you wish the sugar industry to flourish, get rid of the antagonism which at present exists between the factory and the land.

Turning to profit the large means of centralisation at its disposal, let the factory spread among its purveyors a knowledge of the best manures: let it make the production of the seed the point of departure for its manufactures, and in less than three years, in spite of the increase of imports which burden it, and the obstacles which a complicated legislation places in its way, you will see the sugar industry reach a degree of prosperity of which nothing in the past can give you an idea.

You will hardly believe, gentlemen, how I dread exaggerations. When one has truth for one's object, one gains nothing by pushing to extremes even legitimate deductions. I have, therefore, as a principle, rather under than over-stated the facts I have laid before you, and I am satisfied in having done so. You have done me such honour, gentlemen, in inviting me to meet you, under circumstances so kind and flattering, that I hope to have the pleasure of

seeing you again. No personal question is concerned herein. I seek after truth, and you also desire it. No one ever profits by a departure from what is true—from that which can be rigorously demonstrated. I desire that this impression of me should remain with you—that I am a man of good faith, profoundly convinced, one who has devoted his youth and full maturity in the search of laws to which practice places its seal, and who, freely accepting discussion on all points, on all subjects, and always, have no desire at this moment than that of keeping within rather than outside the facts which I have realised. To this question, which is always being asked, and which so earnestly occupies people's minds, "Can we successfully cultivate with chemical manures alone?" I would answer—yes; and justify my opinion by proofs of three kinds. I would call to witness my experiments in the calcined sand, discuss the objections which are brought against it, and show how little they are worth; I would again relate all the favourable facts which practice has acquainted me with. On this occasion, however, I wish to avoid discussion. In the domain of pure science I might perhaps astonish you with the extent of evidence which geology has brought to light, but I wish to avoid, in this lecture, all that belongs to science itself: all that is too abstruse and obscure.

To this question, which, in spite of all, intrudes, and is almost imposed upon one by the force of things—"Can we cultivate with chemical manures?" I will reply by an anecdote, which is very instructive.

By chance, in 1868, I met with M. Cail, of Paris, the great builder, who has also, I believe, a branch establishment in Belgium. M. Cail spoke to me of CENTRAL FACTORIES, which he had introduced into the colonies, and which are, as you know, sugar factories of a magnitude previously unknown. He related to me marvels which he expected from his erections. He said, among other things, that he had determined to establish at Guadeloupe a veritable steam fleet, to circumnavigate the island and go to distant places for the collection of canes. He added that the surrounding plantations were unequal to the supply of those colossal factories, and affirmed also that in one of them they were working up more than 40 millions of kilogrammes of canes in a year.

I asked M. Cail: "What weight of canes, as a crop, do your planters produce?" "30,000 kilogrammes," said he, "which, at the rate of 25 francs, are worth 750 francs." I continued, "And you are embarrassed for want of supplies to your factories, and must have railroads and a whole steam fleet? Leave me to make a trial. I will carry canes to your doors, and you shall no longer be obliged to collect them from a distance. In place of 30,000 kilogrammes of canes in favourable years, your planters shall reap 80,000. You shall increase their income by 1250 francs. For that, what is required? 400 francs worth of manure. The cultivators will gain more, and you yourself will add to your profits. With that increase in the crop of canes I will enable you to prolong the working season by a month, the general expenses remaining the same, by which your gains will be increased in an unexpected proportion."

Like all practical men who know what silver costs to gain, M. Cail said: "You are making game of me; but I am very willing to afford you pleasure: therefore, order for me 10,000 francs' worth of your manure; which I shall, however, look upon as lost."

10,000 francs' worth were sent and used accordingly. The following year he ordered to the value of 100,000, the third year 300,000, the fourth year 1,000,000, and to-day, at the factory of Arboussier, in Guadeloupe, manure works are being built which will supply their planters with double that quantity. All this has been accomplished in less than six years. It began with a doubt, and now the factory of Arboussier, which with difficulty used to get 40 millions of canes in the 12 months, has doubled its mills, and does not work less than 100 millions of kilogrammes. This factory, which had only one high chimney, will now have two—one for the manufacture of manure, and the other that of sugar.

And what manure do they use there? Chemical manures exclusively. How long will it last? I do not know. It is fourteen years since the experiments were commenced at Vincennes, and at Guadeloupe they have been going on for six years. The further we advance the more we shall, perhaps, have a right to say how

it is likely to end. It is possible, but I shall no longer be here to reply to criticisms. In the meantime, I only desire to testify to the facts which are known to me, and which experience has confirmed.

At the end of the lecture M. L. Serstevens, in moving a vote of thanks, spoke as follows:—

Gentlemen,—Our object here is the same as that of M. Georges Ville. By his studies in the silence of his closet, as by his labours in the domain of practice, he has not ceased to seek for a solution of a problem which equally interests us all. I am happy and proud to see so eminent a man as he is, leave his own country to bring us the fruit of his labour and watchful toils.

I would insist more on the title he has acquired to our gratitude, if I did not know that M. Georges Ville finds the recompense of his noble disinterestedness in the conviction that he is successfully labouring for the prosperity of peoples without the distinction of nations.

Your efforts, M. Georges Ville, will not be in vain. In Belgium we also pursue with ardour whatever promises to lead us to the knowledge and application of the means of augmenting the prosperity of our industry and the productions of our fields. We think we have proved it, though but recently, in establishing, with the co-operation of the Government, a station for experiments at Gembloux. Decidedly, this is a question which exceeds all others in importance. To produce sugar, is to make bread and meat cheap. We may, therefore, affirm that in occupying ourselves with a question, special in appearance, we labour at once for the development of agricultural industry and the well-being of the country on the side of its alimentary resources. * * * *

CENTRAL FACTORIES.

On this important question, which is now attracting attention throughout the island, the following very forcible remarks, extracted from a private letter received by a gentleman in this city from a correspondent in England, will doubtless be read with interest:—

In order to know what results were likely to be obtained from a central factory, it would be necessary to have information on many points. For instance, if in Jamaica there is a duty on the import of sugar, this would be a protection to the first central factory put up, and indeed to any others, until the local demand for the finer crushed sugars was fully supplied from local sources; such a state of things would offer a very solid advantage. Then the length of the sugar-making season has much to do with success, because the longer the season the smaller the capital required to turn out a given quantity of sugar, and the smaller the profit needed per ton of sugar.

It is also important to know whether night work is ever done on the island, and if there is likely to be any difficulty in the way of getting abundant and efficient labour at night, for a factory certainly ought to work night and day if it is to pay well.

Of course, the price at which the canes are sold to the factory is a most important element in the question. We have good authority for stating that the late Mr. Cail declined to take any interest in any factory paying more than 5 per cent. for its canes, although the system of duties in France practically protects usine sugars to some extent.

The system of payment ought to be one which should make the planter interested in the success of the usine. For instance, he might receive 5 per cent. for his canes and a share of the profit after paying moderate interest on capital. Thus it would be to his interest to grow as sweet canes as possible, and to deliver them as they were needed by the factory. As you doubtless know, some of the French factories have suffered from the planters being interested only in the weight of cane produced, and not at all in the weight of sugar made from it.

We are more and more convinced that the use of charcoal ought to be avoided in the tropics, wherever it is possible. With charcoal there is of course much sweet water (char washings) to be concentrated; this, together with the reburning of the char, consumes much fuel. Its use adds considerably to the cost of the plant; it needs attention, which is rarely to be had, and is in other respects objectionable.

Where the triple effet is employed, there is of course no choice, charcoal must be used, because without it the tubes of the apparatus would become clogged up with lime, salts, very much more rapidly than even at present.

Where, however, the Concretor is used for concentrating, the necessity for the use of char disappears. Syrup prepared by the Concretor is brighter and better than from the triple effet, and the Concretor furnace is far better suited for burning wet megass as it comes from the mill, than the locomotive furnaces in which a portion of this material, together with coal, is burnt in the French central factories.

You will see, therefore, that we have no hesitation in confirming you in your views as to the superiority of the Concretor to the triple effet for reducing the juice to syrup.

We have fitted up a number of Concretor and vacuum pan factories, which we understand are giving very good results. The following is an extract from a letter received about two months ago, as to the working of the Concretor and vacuum pan factory, illustrated in the newspaper *Iron* a short time ago :—

"As far as the working of the machinery is concerned, there is nothing to be desired. The mill is the most perfect thing of the kind I have yet seen, and fills seven clarifiers per hour with the greatest ease (clarifier capacity 380 gallons each), and I would guarantee to get eight by driving her. When working with the Concretors, betore the vacuum pans were erected, I have made 25,000 lbs. Muscovado per day, and I believe the apparatus can be marked up to 60,000 per twelve hours. We shall turn out as good a sugar, if not better than that turned out from the Killieux trains with charcoal filtration and tripple effet evaporators."

There is no doubt that a well designed and well managed central factory will give very much better results than can be obtained with the ordinary Muscovado process, but the margin is not so great between the results which are to be expected from it and those obtainable by a planter making concrete. This is supposing the conditions of sale to be equal, and that the sugar made must in any case go to Europe. If, however, the whole product of

the central factory could find a sale in the island it would be protected —

1st. By the amount of export duty, if any.

2nd. By the amount of freight and charges home.

3rd. By the amount paid for freight and charges on the refined sugar, of which it takes the place.

4th. By the amount of import duty.

It is probable enough that that portion of the product which could be sold in the island would be profitable to make even if it would entail an absolute loss to make it and send it home.

Should this central factory be erected, the greatest attention to the carrying out of details would be desirable, and we think it would be well if you could come over and discuss these details with us.

Your views with respect to finance are very sound. If the Jamaicans will help themselves and start one factory, they will no doubt find it easy to get home capital for others; but I do not think they would easily obtain it for the first. If there is any difficulty in getting sufficient capital, there is the example of St. Lucia before their eyes. For that factory the Government provided £25,000 in capital, and, I believe, also a guarantee. Though we may think that this is not the business of Government, yet to do it in Jamaica would be much more sensible than in St. Lucia, as in your largest important colony there is a wider field for the development of the system when proved by experience to be advantageous to the island. You know it is our practice always to sell our machinery for strict cash upon delivery at shipping port in England, and we believe it is not to the purchaser's advantage to buy machinery upon credit.

In this exceptional case, however, if it appeared really necessary for the well-being of the Company, we would go out of the way to help them, and would allow some portion of the payment to be delayed.

As you know, the general views of Mr. Fryer and ourselves on sugar manufacture are usually expressed in the recognised organ of the sugar trade (*The Sugar Cane*), and we should strongly

recommend your planters to study this periodical. If also they would take such an interest as to contribute any information they may have in respect to results obtained by special methods of planting, by irrigation, or by particular methods of manufacture, such contributions would be welcomed.

By the time this letter reaches you, Mr. Fryer and myself will probably be on your side of the Atlantic, but we are not likely to find our way to so low a latitude as Jamaica, nor do we expect to be long away.—"*The Kingston Budget*," Jamaica, Sept. 24, 1874.

As it is evident the Jamaicans are awaking to the necessity of progress, a few facts communicated through your esteemed journal may prove interesting to your readers; who are I believe the majority of the intelligent inhabitants of the island.

Central sugar factories or "usines" are, in the French Antilles, a successful fact, they have brought prosperity and comfort to all classes.

Guadaloupe has several, and boasts its sugar palace, the Usine d' Arboussier, which cost £216,000 stg.

Martinique has fifteen usines on which have been expended £860,000 stg.

St. Lucia aided by the Colonial Government is constructing one at a cost of £100,000 stg.

The Danish Government is patronising the proposed erection of two sugar factories in the small island of Santa Cruz, and numbers of them are in successful operation in the Spanish colonies.

In the island of Trinidad the Colonial Company have taken the initiative, having established in South Naparima an extensive factory. In that island coasting steamers have been plying between Port of Spain and San Fernando, making occasional trips to La Bien and Cedros, for upwards of twenty-five years, to my knowledge.

St. Lucia has for many years had a very serviceable steamer, which cost £1000 stg., trading between Castries and Sonfriere daily; making also three trips weekly to Vienn Fort, touching at the intermediate towns of Choiseuil and Labourie; and few speculations have ever paid better.

Martinique has two steamers plying daily between Fort de France and Saint Pière; and steam tugs towing passage and freight boats crowd the bay of Fort de France; each sea-side usine has one or two such steamers. There is communication twice a day between Fort de France and La Martin, and between the former and Petit Bourg; both towns some distance inland at the further extremities of the bay, but having creeks or rivers leading to them; this service is done in either case by small tugs, towing barges for passengers and freight. The number of passengers and quantity of produce and provisions of all kinds brought into the capital daily by these boats is considerable; supplies which never could reach the city but for steam communication now fill the markets. Country people, who formerly never saw the city, now congregate there to make their purchases, sell their produce, and return to their homes in the evening.

In Porto Rico, a few years since, a journey from Ponce or Mayuguez, or any of the intermediate towns, to the city of St. John's required serious reflection; it had to be done on horseback or by drogher; within these last four or five years, good carriages are run between all the principal towns daily and at stated hours, passengers or no passengers; and the enterprising man who started them has made a fortune.

The R. M. S. P. Company sends one of its smaller steamers from St. Thomas three times monthly, the first trip she calls at the city and then proceeding by the east and south coast touches at all the principal seaboard towns, distributing the European and Colonial mails and passengers, and passes on to Porto Plata; on her return she calls again at all the principal towns and takes mails and passengers to St. Thomas. On her second trip after calling at the city, she proceeds by the northside and makes the circuit, distributing the second monthly mails, and then returns in the opposite direction for those for Europe and St. Thomas. As the Mail Company is pretty well alive to its own interest, and it is nearly three years since this service was established, I presume it pays.

But besides this; there is the Spanish coasting steamer, taking

passengers and goods, and making the circuit of the island four times a month. The Cuban and St. Thomas line of steamers calling at Mayuguez, and St. John's, and the intermediate ports three times a month going and coming, and occasional steamers which call in monthly at various ports and generally proceed on to the city; and this all takes place where ten years since traffic was a dead letter; and persons wishing to go to Europe found more difficulty in making the journey from Ponce or Mayuguez to the city, than from thence to Europe.

These are small facts worth knowing, especially when coasting steamers are so much wanted, and so much talked about in Jamaica, and might be made a paying speculation, would any enterprising man only act.

R. E. Burton.

(*From the "Colonial Standard and Jamaica Despatch."*)

MASON'S NEW SUGAR APPARATUS.

The *Louisiana Sugar Bowl* of the 5th March, 1874, quotes from the *Q. C. Republican* the following account of "Mason's new Sugar Apparatus":—"A limited party of gentlemen took the small steamboat 'Little Jerry' to visit the Belsa Cane plantation, about eleven miles down the river, to witness the operation of a newly-invented apparatus to increase the amount of juice taken from cane, and another machine used to evaporate the juice by a new system. The invention belongs to a Mr. A. W. J. Mason, associated with Mr. J. Hennessey, the copper worker. The saturator will be considered first. After the cane has passed through a crusher, as usual, Mr. Mason's machine takes up what is called megass, runs it thence to an endless wire apron, which passes into a series of close chambers, fitted with small rollers, at proper distances. Into these chambers or boxes, jets of exhausted steam are sent, where the wire apron is double, the megass being inside, and every time the steam exhausts, a stream is poured over the now thoroughly crushed cane, dissolving all the remaining

crystals, converting them into juice, which easily runs down the inclined chambers, to a proper receptacle. The megass, when delivered to the second pair of rollers, has become exceedingly soft, where it is pressed and passes out in sheets to the dryer. This dryer is constructed somewhat similar to the saturator, and currents of heated air, from beneath the boilers, are forced through, so that when the megass is delivered to the shute, to be conveyed to a furnace, it is ready for immediate use. The hot air is that which otherwise would go up the main chimney first. The juice is now transferred to the regular clarifier, where it undergoes the usual process; thence to the receiving tanks. Then it is sent to a tank above, in order to give it a fall to the evaporator. By a pipe the liquid is sent to a new machine, which may be made of almost any capacity, say up to as high as twenty hogsheads, if required. The evaporator is a horizontal cylinder, with door of any size the owner pleases. Outside the building is a furnace for heating air, and a pipe connects with the evaporator, with cut-off. A blower drives cold air into the pipes heated in the furnace, at the same time being connected with the evaporator in such a manner that cold air can be introduced at pleasure. This cylinder has a shaft from end to end, on which are placed upright discs, not unlike cotton gin saws, five-eighths of an inch apart. These occupy nearly all the space. The drum is then partly filled with prepared juice, the hot air let in, and the engine started. These discs fly around in lively style, keeping the liquid in continual motion, and the manipulator can easily keep the temperature at any degree he pleases. It is usual to keep the hot air at about 250° Fahr. This heat is so tempered by the rising fumes that the juice cannot rise to above 155° Fahr. A thermometer is so placed that the attendant can keep his eye constantly on it, and by means of gates can command as much hot or cold air as he pleases. Thus the juice is changed in its nature at a low temperature. By the old mode in kettles it frequently occurred that the temperature rose to near 300° Fahr. in the centre, but the usual heat is 212° Fahr. for boiling in open air, thus destroying a portion of the saccharine crystals and carbonising them, giving an undue quantity of

molasses. It will be seen that this system ignores kettles and all the attendant labour and expense. The juice (now syrup) is evaporated to a density of 27° Baumé, and then transferred to a tank to settle, until there is sufficient to make a strike or strikes. Once more it goes back to the same machine and is manipulated as before, when it is drawn off to a cooler, then transferred to the centrifugal to be operated on, or transferred to the hogsheads to drain. Concerning the improvement in expressing the juice, the gain is fully 20 per cent; gain to the sugar also 20 per cent., besides being so much brighter, in consequence of the low temperature employed. The evaporator, by means of the constant and powerful currents of air passing in and through it, decolorises the molasses—a great improvement, which was especially commented on by Mr. A. Thompson, of the Crescent Refinery, and his manager, Mr. E. E. McDowell. Saving in fuel is about one-fourth; and the value in machinery one-sixth of the vacuum-pan. The guests, most of them planters and practical gentlemen, witnessed the operation, and without exception approved of it. Bottles of this *cuite* were taken away by the excursionists, and they were compelled to break the bottles to get out the sugar. This experiment was scarcely a fair test, as the juice had been evaporated three times before, and the cane had been frosted.

STEAM AND ITS USES ON PLANTATIONS.

(*Continued from page* 510.)

From personal observation of the application of steam power in cultivating, together with a careful and extended examination of numerous reports by inspecting committees and farmers in Europe, who have had large experience in its use, I am convinced that it can be adopted in this country with great facility and profit, and that it is the desideratum, the great thing now needed, to raise and advance farming to the highest scale of prosperity and dignity, in which men of the best minds, highest culture, and broadest views,

will delight to engage and find scope for enlarged intellect and ambition.

A trial of the circular ploughs being much desired, the nearest ground thought suitable where water could be had was about one quarter of a mile distant. The boiler was pumped up nearly, and the water casks full of water for the trip. With steam at about forty pounds, the traction engine started for the ground selected. After running a short distance, the water (too much and too muddy) in the boiler commenced foaming, and from both engines, particularly the uncommon one, and, through the safety valve, water and mud were thrown out so much that the engines worked slowly, and with irregular speed, which produced jumping of the front part of the machine. The throttle valves were closed to allow the foaming to subside. After delaying a few minutes, progress was again made, the condition of the road necessitated running in a zig-zag manner, during which the fore wheels were alternately raised from the ground to an extent that there was a tendency towards a turn over or capsize of the machine, and in addition, when near the ground chosen, the other countershaft became twisted and crooked, somewhat like the first heretofore mentioned. A few days' work remedied the former (lowered the bearing or bolster support on the fore wheels' frame) as much as possible, and the latter temporarily.

Steam up again, the place desired was soon reached with some difficulty, the road where it crossed a ditch being in bad condition. A supply of water being obtained from the ditch mentioned, the circular ploughs were attached and the steam mule advanced; but the chain pulleys, that give motion to the ploughs, contrary to that of the round coulters, being smooth, and no hold back rod to the gang frame (not made at the suggestion of others, who thought it useless), the former slipped on the smooth pulleys; consequently the ploughs had not the motion required, but rolled over the ground as a wheel, without cutting. The soil was very hard and tough, having been trod by the feet of animals for about thirty years without being disturbed. Regardless of the ground, the common ploughs were hitched on in place of the circular, when the steam

mule again progressed and cut from three to four inches deep of irregular breadth, jumping considerably. Had the coulters permitted the ploughs to enter the ground fully, probably they would have been broken, on account of the extreme hard and tough ground. Since these attempts, part of the ground has been ploughed two or three inches deep, by animal power. Such ground being entirely unsuitable for trials of either kind of ploughs, further efforts at the time were abandoned, and the traction engine run back from whence it came with considerable trouble, in consequence of the mended shaft being weak, and a bad road.

The mended shaft strengthened the second time, pins or teeth drove in the chain pulleys, and a hold back rod provided for the gang frame of the circular ploughs, another trial was made under unfavourable circumstances (after a shower of rain), but notwithstanding the driving wheels of the traction engine slipped considerably on the wet, grassy ground, the ploughs, two in number, with steel cutters two inches wide, alone, without extra weight or contrivance to force them downward, cut or slit hard ground, in an old brick yard, over three inches deep and fifteen inches apart, and before stopping ran over a fence picket lying on the ground, splitting it two or three feet, without injury to the ploughs; steam throttled at the engines to about 40 pounds. The hardness of the ground prevented the round coulters or vine cutters, in advance and belonging to the circular ploughs, from doing any good, as there was nothing on the gang frame to force them into the ground.

A second trial of common ploughs being next in order, two of them with common coulters were hitched by chains to the steam mule. With steam same as first trial (50 pounds), and on the same ground, they cut from four to five inches deep, and over eleven inches wide, the hard ground getting the coulters out of place, and causing the ploughs to jump and hard to hold.

When the engines were obtained, it was doubted whether they would have sufficient power to propel the traction engine and a gang of three ploughs (the least number found profitable with steam in England) in breaking up hard ground, but it was believed they

would have power for four ploughs, at least, in cultivating on average or favourable ground. This, the last trial indicated, could be done, and most probably better. It was feared, however, that the weight of the boiler, engines, &c., on the driving wheels, needed there for traction in breaking up hard, tough soil, would, in cultivating on soft or yielding ground, cause them to settle or pack the ground, thereby causing loss of much power.

It was thought, without full reflection, that this could be remedied by diverting part of the weight stated to the fore wheels, at will, by means of hog chains. Experiments with the model and traction engines were not satisfactory, but induced the belief that additional or regulating wheels in the rear of the driving wheels would accomplish the purpose desired. A pair of the same were added, plainly foreshadowing that the object would be attained and be of great advantage in crossing bridges, small canals, and unbridged ditches. Regulating wheels were forthwith made and attached to the traction engine, and meagre trials thus far indicate or assure that this improvement, to regulate traction and distribute weight, is one long sought for in traction engines, especially those intended for agricultural uses; and the fact that locomotives, passenger and freight cars, on railroads of late years have increased number of wheels for the same purpose, tend to prove it, nor is it improbable that such wheels will be found useful on common waggons, ere long. A marked feature of them is that they can be easily attached or detached to suit load or road.

To insure full utility, it is important that the hand gear or means that govern their use should be of easy control to the engineer or driver, in order that the wheels can be accommodated to the varied inequalities of road or field. The track of railroads being level, increased number of wheels on them accommodate or bear equally themselves on the rail, without anything to govern them.

IMPROVE.

REFINING IN BOND IN QUEENSLAND.

In the Legislative Assembly of Queensland, July 9, 1874 :—

On the motion of Mr. Nind, it was affirmed in Committee that it was desirable to introduce a bill to enable persons in certain cases to refine sugar for exportation only. On the resumption of the House, the bill was introduced and read a first time. On moving the second reading, he said that it was not in any way an insidious bill, but simply a measure of justice. Its main object was to put the Queensland refiners in the same position as those in Sydney and Melbourne. If this bill were not passed there would be no hopes of establishing refineries for years to come. It was an industry that must be established on an extensive scale, and would require to keep it going perhaps ten times the quantity of sugar now grown in the colony, although this year they might be in a position to export a few thousand tons. No sugar refinery could be profitably established to refine less than eight or ten thousand tons of sugar per annum. The main essence of this bill was in clause 2, which provided that the owner could remove sugar from the Custom-house without paying duty, provided that he guarantees that the sugar is for refining only. It was also provided that the refiner would be required to export an equal quantity of refined sugar within ninety days. As the waste in the refinery of sugar was 25 per cent., it would leave a margin to that extent in favour of the local grower. At present they were making so much sugar that they were obliged to export, and the price was ruled by the Melbourne market. This bill, instead of doing the growers harm, would do them good, as it would enable them to produce a more marketable article. He thought everyone would agree that it would be an advantage to the colony to have such an establishment here as a refinery, employing skilled labour and dispensing other benefits.

Mr. Hemmant would offer no opposition to this bill, on the understanding that the bill would remain in force for three years only. He would also propose an amendment, that any expenses

incurred by the Government in carrying out the Act should be borne by the refiner. If the representatives of the sugar districts were of opinion that the bill would do no harm, he thought that the House might very well assent to it.

Mr. Bell said that the bill was, although a simple measure, a most important one, and had his hearty assent. He did not think that it would in any way jeopardise the revenue of the colony.

The question was then put and passed, and the House went into committee on the bill.

Clause 1—Repealing the Bonded Distilleries and Sugar Houses Act of 1872, was agreed to.

Clause 2—Owner or consignee of imported raw sugar in any bonded warehouse entitled to receive and remove same without payment of duty. Provided that such owner, consignee, or agent, first make statutory declaration that sugar is removed for the purpose of being refined. Provided that owner, consignee, or agent, enter into approved bond in a sum double at least of the duty for the exportation of equal quantity of refined sugar. Such bond not to be discharged until bills of lading, &c., of shipment for exportation produced, or on payment of duty or interest.

The clause was amended to the effect that satisfactory evidence must be produced to the collector of the exportation of the sugar.

A new clause was inserted on the motion of Mr. M'Devitt, providing that the expenses incurred in carrying out the Act should be paid by the refiners.

Mr. Hemmant proposed a new clause, providing that the bill should only remain in force for three years.

Messrs. Nind, Bell, and Palmer opposed the clause, the latter arguing that the clause was a most insidious one, and would give the monopoly of the industry to one firm, as it was not likely that persons would erect expensive works under an Act that expired in three years.

The clause was put and negatived. The other clauses of the bill were agreed to.—*Brisbane "Queenslander."*

NOTES FROM THE CONTINENT.

We learn from the *Journal des Fabricants* that "the fine weather we enjoyed (in France) during the previous week was broken on Monday last by abundant rain, which lasted twenty-four hours, which, however, can scarcely affect the beetroot, which was being rapidly transported to the factories. The high temperature of last week has caused an appreciable diminution in the richness of of the roots, which can only be arrested by colder weather. As respects the yield, it will certainly not exceed the anticipations we ventured upon in September. Many of the *usines* which were apprehensive of a deficit will get their ordinary supply, but the return in sugar will be less. On the whole, we do not think we shall have occasion to modify our estimate of a production equal to that of last year. In Belgium, also, the situation is similar to that of France."

From Magdebourg, M. Licht reports on the 17th October, that the month "is drawing to an end without any rain. The waters of the Elbe and its affluents have become lower than they have been known to be for forty-six years. Boatmen, millers, &c., are complaining more and more, and we have again heard that, from want of water, several sugar factories have stopped working, or have restricted their operations. The nights are humid and the dews abundant, which is favourable to the beet, both as regard quantity and quality."

M. Achleitner, of Vienna, states on the 15th October, that "the weather continues invariably fine, but has begun to assume somewhat of an autumnal character. The evenings and mornings are sensibly colder; in the day we have bright sunshine. The gathering of the beetroot is in full activity, as are also most of the factories. The probable extent of the crop cannot yet be exactly estimated, but we have every reason to hold to the opinion expressed some time ago, that the deficit will not exceed 15 per cent. in the whole monarchy, taking into account the good quality of the roots."

FROM THE BRITISH COLONIES, &c.

The reports we receive are invariably good.

From the *Kingston Budget*, Jamaica, of September 24th, we learn that "seasonable weather prevails throughout the line of country extending between this and the parish of Clarendon. In Vere the rains have been heavy and continuous within the past few days. The cane fields are blooming, and the sanguine expectations of the planters are not simply for good, but for unusually good crops."

With regard to ANTIGUA, the *Barbados Globe*, of September 28th, says: "We are happy to be able this week to congratulate those who are agriculturally interested in this island, on the more cheerful prospects which the recent change in the weather is calculated to produce. After a long spell of dry weather, and consequently a great deal of mental anxiety and depression, the heart of every planter within the island must have been gladdened on Wednesday last by the heavy rains which fell over the land. As usual, however, some districts received more of it than others. The north-east and eastern districts were the least fortunate, while over the south and western parts, the fall was greatest—even Popeshead to the north received, we understand, a good drenching. The rainfall on that day in the city was recorded at the Public Library at 3·12 inches, but diminishing gradually towards the east. Near the centre of the island the fall was about 2·20 inches which is probably close on the average fall for the whole island, on that day. The total rainfall in the city, from the first of the present month to date, is 4·14 inches; for August, it was 5·98; and July, 3·33. In 1873, the fall for July was as low as 1·75; for August, 4·63; and to 12th September, 1·05. The rain on Wednesday was accompanied by several loud claps of thunder and vivid flashes of lightning. Several good showers have fallen since, and from the extreme sultriness of the air, it may be inferred that much more rain is coming. Altogether the present weather is highly favorable to the growth of the sugar cane. The young plants are looking exceedingly healthy."

The same paper also says with regard to the condition of Barbados:

"September has favoured us with abundance of fine rains. Yesterday it fell at intervals through the day; and on the 19th there was a heavy downpour, which caused the gullies to run to an unusual height. Our planter friends must feel great pleasure when they behold the luxuriant appearance of their beautiful fields of canes, and have good reason to entertain the hope of reaping a fine crop next year. The canes everywhere look admirable, and in the parish of St. Michael they have a lovely and charming aspect, especially at Lears, The Belle, and Waterford. A magnificent stand of very forward canes can be seen at Haggatt Hall, Lower Birney's, Jackman's, and Bushhall. In St. Thomas, where the rainfall for the month has been from 15 to 16 inches, the crop is not anywhere inferior to the other parishes. The canes at Arthur Seat, Warrens, and Jackson are under a powerful growth. The crop at Arthur Seat is estimated at from 85 to 90 hogsheads. The eddoe and yam crops do not look so favourable, although on some plantations, where some flourishing vines can be seen, they promise well. Potatoes are not so plentiful this season as they should be; they are selling eight pounds for fivepence. A good crop of Indian corn has been broken; the largest quantity reaped is said to be at Waterford."

In Louisiana, the *New Orleans Picayune* informs us that: "Not since the good old time when this State produced four hundred thousand hogsheads of sugar and as many bales of cotton, has the cane along the coast exhibited so healthful and promising an appearance as now. The vast sea of bright green, waving too and fro under the pleasant breezes, which for several days past have swept over our delta, is one of the most animating spectacles that can be witnessed on this continent. It springs up ten or twelve feet high, with its enormous growth of leaves, completely concealing the ground and all other objects, making a vast carpet of verdure, perfectly even and smooth, matted and interlaced as if a solid mass of vegetation with the heavy leaves nestling against each other like so many gorgeously attired dames in a crowded saloon. Altogether there is nothing in the form of agricultural scenery picturesque and

grand as these great cane fields of our planters ; no more delightful excursion at this time of the year than that on one of our great river steamers through the sugar regions of our State.

The effects of so promising a prospect of the main product of our alluvial section may be seen in the general vivacity of the inhabitants of all classes along the coast. Hopefulness and cheerfulness appear to pervade the whole population. There are busy preparations for the grinding season. The work is now chiefly about the sugar-house—mending the machinery, setting the kettles, sharpening the cane knives, slacking the wood, or hauling the coal, and gathering the corn. The mules, too, are given a chance to fatten and invigorate for the hard work of hauling the heavy cane ; the roads and bridges are being prepared. The whole coast is busy and noisy with notes of preparation for the harvest, which promises to be by far the largest since the war.

Despite the efforts of demagogues and persistent agitators, the hands on the plantations appear to be absorbed in their duties and labours. And thus for the present, at least, is the great peril to a large and profitable production of this valuable staple postponed and avoided."

From QUEENSLAND we hear that "cane crushing" (in August,) "is general, both in the north and south. The density is high, ranging from 8 and 10½, where the cane is sufficiently old. On the Mary, one or two mills commenced crushing in June with satisfactory results."

HISTORY OF THE SUGAR CANE IN AUSTRALIA.

(Paper read by Mr. Melmoth Hall, at a Meeting of the Agricultural Society of New South Wales, under the Presidency of Sir Hercules Robinson, K.C.M.G.)

THE EXPERIENCE OF THE COLONY IN THE GROWTH AND VARIETIES OF THE SUGAR CANE BROUGHT DOWN TO 1873.

It is to be regretted that the gentleman who had undertaken to furnish this paper could not sooner have communicated to the secretary his inability to carry out his intention, so that time might have been afforded to collect

information upon many points of interest connected with the earlier history of the sugar cane in this colony. For this I had necessarily to depend upon others, and though no delay occurred in my applying to my acquaintance in the country as soon as I found myself in a position to supply this paper, even the additional week allowed me for preparation has not permitted the replies of some who reside at a long distance from Sydney to reach me in time. This must serve as my excuse if anything of interest appears to have been omitted.

I take this opportunity of returning my best thanks to Dr. Bennett, Mr. John Crispin, Mr. O. O. Dangar, Mr. John Duff, Mr. E. W. Knox, Mr. Alfred Lardner, and Mr. Thomas Scott, for their prompt and courteous replies to my letters, and to assure them that by their means I have been able to add much valuable matter to this treatise.

Introduction of the Sugar Industry.—Without controversy, New South Wales owes the starting of the sugar industry to Mr. Thomas Scott. In the years 1817 and 1819 he introduced from the Society Islands the first sugar canes ever grown in the colony, and in 1823, at Prospect, on the Hastings River, in spite of great difficulties, proved the suitability of the soil and climate for their profitable growth, in a commercial point of view, by making between four and five tons of sugar from his yellow Tahitian cane, and in 1827 by manufacturing as much, it has been publicly asserted, as 70 tons at Rolland's Plains, with indifferent machinery, and implements chiefly of his own construction. Here the subsequent destruction of his canes by fire, and the want of adequate support from the Government, caused him to abandon the further prosecution of the industry, but he still continued perseveringly to keep the subject before the colonists by periodical letters to the public prints, and by the frequent exhibition of small samples of sugar made by himself.

It was not, however, till the year 1868 that attention was much or generally aroused. During the first two months of that year a series of letters from my pen, entitled "Simple Directions for the Profitable Culture of, and Manufacture of Sugar from the Sugar Cane," appeared in the *Herald* and *Mail*. In July, a report of a lecture delivered by me at Croki, and an account of the sugar cane of the Manning River, whither I had gone on behalf of a projected sugar company, were published in the *Herald*. These were supplemented a few months later by reports of a number of lectures on the cultivation of the sugar cane, delivered by me to the farmers of the Clarence and Macleay Rivers respectively, and by an account of my visit to those rivers, whither I had been instructed to proceed by the Colonial Sugar Refining Company. These more than confirmed all that I had previously asserted of the promising appearance of the sugar cane plantations; and the fact that about this period, namely, the latter part of the year 1868, Mr.

Richard Meares had succeeded in manufacturing sugar of good quality, and in sufficient quantity, and at a price to establish the industry as a financial success, intensified the interest and excitement.

Sugar Mills.—From this time a large number of sugar mills, of all sorts and sizes, began to be erected on the Clarence, Macleay, Hastings, and Manning Rivers. Mr. Richard Meares was the first to have a mill of any size in the colony; this was erected on his property on the Hastings. Mr. Neads and some other gentlemen subscribed together and put up a small mill at Kempsey, and Mr. Holland about the same time had one at Port Macquarie. The first really large and powerful mill was erected by the Colonial Sugar Refining Company in 1869-1870, at Southgate, on the Clarence; and in the same year another still larger and more powerful was put up by the same company at Darkwater, on the Macleay. This last, I may say, *en passant*, owing partly to the farmers not extending their cultivation sufficiently to nearly provide the cane required to keep the mill employed, but mainly to the losses from floods and frost causing low density of juice and consequent difficulty of working profitably, was in 1873 removed to the more favourable locality of Harwood Island, on the Clarence River, within a few miles of which, in the year 1870-1871, a mill of precisely the same dimensions had been put up on Chatsworth Island, north arm of the same river.

Of these mills—such of them at least as are of a superior class—excepting those of the Colonial Sugar Company, it is suggestive how many have suspended operations or have changed hands, and that more than once. On the Clarence, the Joint Stock Proprietary Mill at Ulmarra; on the Macleay, Mr. Verge's mill, Mr. Poole's mill, Mr. Aurousseau's mill, which has undergone alterations and changed hands two or three times; on the Hastings, Mr. F. Bell's mill, erected at Fernbank, re-erected on Mr. Richard Meare's estate by Mr. George Morrison, and since removed again, I believe, to Queensland; Mr. Richard Meare's mill, disposed of to Mr. Morrison, and now I am told idle; Dr. Neild's mill, now in possession of Messrs. Ross and Young; and Mr. Ewan's mill. In each of these cases failure may be fairly attributed to lack of sufficient capital or experience, or both.

The mills erected by the farmers, and worked by themselves, are mostly on a very small scale; and so far as has transpired, the result in the majority of cases has not been encouraging. The fact is, so long as their sugar can be sold to local consumers at retail prices, a tolerable profit may be realised, but the demand is limited; and so soon as the farmers have to export their sugar, and incur all the expenses of freight, commission, and other charges, besides having to compete with the skill, experience, high-class machinery, and economical management of the large millowners, it is a question

whether they would not find it more remunerative to sell their cane than to manufacture it.

The small millowner has certainly the advantage of being able to depend upon the members of his own family; and, while they suffice for all the work both of manufacturing and cultivation, he will, at least in appearance, compete, with some measure of success, against his wealthy neighbour, who has to depend wholly upon hired labour. But whenever the farmer has also to pay wages he will find his apparent profits fast disappear. Farmers know nothing of accounts; and, while using the services of their wives and children, they make no charge against the sugar for their labour; so that the profit they seem to make is really fictitious—less even perhaps than their united wages would amount to, particularly if they worked anything like as hard for their employer as they do for themselves. There is every reason for believing that the Colonial Sugar Company are satisfied with their success hitherto, and with their prospects of success in the future.

Extent of Sugar Cane Cultivation.—Unfortunately, little reliance can be placed on the published returns either of the number of acres of sugar cane under cultivation, or of the quantity of sugar manufactured from year to year. A very cursory examination is sufficient to establish this. In the "Industrial Progress of New South Wales," under the head of "The Sugar Cane," it is stated that in 1867 there were about 116 acres of cane crushed, and 17,786lbs. of sugar made. Now, setting aside the question, "Where were the mills in 1867 to crush from 2500 to 3500 tons of cane?" the returns make a yield of only 153 lbs. of sugar—or say, at 4d. a lb., £2 11s.—per acre. Not an inducement, one would suppose, to any marked extension of the cultivation. And yet, in the following year, 646 acres of cane are returned, and their yield 134,740 lbs. of sugar; this is better, equalling about 208lbs., or something like £3 9s. per acre, but still far short of such a return for labour as might be supposed necessary to induce the farmer to cultivate sugar cane in preference to corn. Notwithstanding, in 1869 we find no less than 2548 acres planted in cane, and 3,264,824 lbs. of sugar made; and in 1870, 3917 acres of cane, and 3,563,704lbs. sugar.

It might be fairer to assume that the bulk of the whole area reported under cane in any one year was not cut and manufactured till the year following. But, taking this as the basis of calculation, the following are the results:—

In 1867 there were	116	acres, and the manufactured sugar was		nil.
In 1868 there were	646	do.	do.	134,740 lbs.
In 1869 there were	2548	do.	do.	3,264,824 lbs.
In 1870 there were	..	do.	do.	3,563,704 lbs.
Total acres....	3310	Total yield of sugar....		6,963,268 lbs.

Equalling 3108 tons, or under 1 ton sugar per acre; so that they are obviously very wide of the truth.

The Registrar-General's returns give the following :—1864, 2 acres; 1865, 22½ acres; 1866, 141 acres; 1867, 116¼ acres; 1868, 646¾ acres; 1869, 2584¼ acres; 1870, 3917½ acres; 1871, 4082¼ acres; 1872, 4393¾ acres. Applying a similar test, the inaccuracy is at once apparent. I will assume, for example, that the cane returned in 1871 was not manufactured till 1873. The amount is 4082½ acres; at 1½ ton of sugar per acre, a low average for New South Wales, the yield should have exceeded 6000 tons, whereas it is very well known that it fell short of half that quantity. In fact, it is impossible to obtain even a reliable approximate account of the number of acres annually devoted to the cultivation of the sugar cane in this colony, partly from the inexactitude of the growers, and partly from a prevailing indisposition to supply accurate information of any kind to Government officials; neither can reliable information be obtained of the mean weight of cane cut per acre; so that there is really no sufficient ground on which to build an accurate estimate of the real sugar cane acreage on any year.

Varieties of Sugar Cane.—The first I will refer to is the "yellow Tahitian cane." This was introduced into the colony from the island of Tahiti, by Mr. Thomas Scott, early in 1817. Mr. Scott continues an advocate for the cultivation of this, to the exclusion of all other varieties. He states that the "Bourbon, ribbon, and other kinds" (I quote his own words), "though infinitely superior both in beauty and in size, have been all tested in the West Indies, but have given way to the yellow Tahitian, which has for ages been the only kind cultivated there; while, but for its enduring quality, the New Orleans sugar plantations would never have existed." I have pointed out repeatedly that the cane which is known in the West Indies as the Otaheite cane is totally dissimilar from Mr. Scott's yellow Tahitian. Wray speaks of the Bourbon and Otaheite as "being so much alike in all respects," that he has "long been of opinion that they are the same variety of cane." For the purpose of comparison, a description of the two kinds is subjoined :—

Otaheite or Bourbon of West Indies.	Yellow Tahitian of Mr. Scott.
Quality of cane—soft and juicy.	Hard, solid, and woody.
Juice—abundant.	Deficient.
Habit—bending, clean, with little tendency to "spring," half hardy.	Very erect, foul, great tendency to spring and throw out roots from rings; very hardy.
Colour—straw coloured.	Gray green, inclined to pale yellow; occasionally rosy yellow, often covered with whitish bloom.

Number of canes per stool, 12 to 25.	20 to 45.
Height below lowest green leaf, at 12 months, 5 to 6 feet.	6 to 8 feet.
Girth midway between lowest green leaf and ground, $4\frac{1}{2}$ to $7\frac{1}{2}$ inches.	3 to $4\frac{1}{2}$ inches.
Internodes—slightly bulging between rings, which are $3\frac{1}{2}$ to 6 inches apart.	Of nearly uniform thickness, but somewhat largest at rings, which are 5 to 7 inches apart.
Foliage—pale green, broad, drooping, serrated edge, easily detached when withered, little "itch."	Light green, narrow, erect, smooth-edged; detached with difficulty when withered; no "itch."

I have never disputed that Mr. Scott brought this cane from the Island of Tahiti; all I maintain is that he errs in asserting its identity with the cane cultivated in the West Indies as the Otaheite. That cane I believe to be the Vaihi, introduced into Tahiti—so the natives say—from the Sandwich Islands; while Mr. Scott's cane, I have no doubt, is the "Irimotu," a rich but small, hard cane much esteemed in the Islands.* The former has assuredly not yet found its way into this colony. Three cuttings sent to me from the Java Botanical Gardens were unfortunately dead when they arrived. The yellow Tahitian cane of Mr. Scott I recognise as very similar to the China cane—S. sinense, of Roxburgh. It possesses the excellent qualities of being able to resist degrees of cold which injure less hardy canes; it also withstands the effects of both drought and excess of wet. It is not impossible that in the more exposed situations or lower latitudes it may be found a useful cane to cultivate, but on the Clarence River the Colonial Sugar Company have not found it a sufficiently profitable cane to manufacture; and their refusal to purchase it from the farmers have caused its cultivation there to be discontinued. It has repeatedly flowered in different parts of the colony.

The next cane I will mention is that commonly known as the ribbon cane. This variety also, I have little doubt, we owe to Mr. Scott, who brought it, as well as the yellow Tahitian, from the Society Islands in 1817. I believe it to be the same as the purple-striped Otaheite of Wray, the Guinghan of Mauritius, and the To-ura of Tahiti. Up to this time it has proved unmistakably the best cane we possess. It is sweet, hardy, and prolific, ratoons well, has not yet flowered, and has hitherto escaped injury from disease. I have reason to think that it is only a sport from the

* Dr. Bennett names the following eight varieties as growing in Tahiti:—1. Rutu, of good quality. 2. Avae, indifferent. 3. Irimotu, a rich, small cane. 4 Patu, a good red-coloured cane. 5. To-ura, a dark striped cane, hard and good. 6. Toute, a bad red cane. 7. Veu, a good cane. 8. Vahi; this attains a large size, and is considerably of the best quality.

Otaheite cane or Vaihi, to which, in all respects but the colour of the cane, it bears a strong resemblance. In support of this opinion I must state that I have, in one instance, seen no less than three distinct canes springing from one stool of the ribbon variety—one entirely yellow, another entirely green, the others being the usual ribbon canes; while from other stools in the same field I found canes either of a uniform green, purple, or purplish brown, all the rest springing from the same ribbon cane root being striped in the customary way. The cuttings from these sports perpetuate the variety, and have usually some distinctive properties, such as rapidity of growth or sweetness of juice; notably so in the case of the yellow cane, about an acre of which I saw growing on Mr. Richard Meares' property on the Hastings, at the time in possession of Mr. George Morrison—a recent arrival from the West Indies—who assured me that it was the genuine Otaheite cane, from which indeed it was hardly to be distinguished. But subsequent inquiry convinced me that it had originated in a similar sport from the ribbon cane, than which it is said to be a good deal sweeter. I have discovered this disposition to "sport" in other kinds of cane, as for instance in the dark and light purple, from each of which I obtained permanent varieties of handsomely striped canes, and which I named respectively Somerville's and Bale's ribbon, from the farms where I first saw them growing. This leads me to suppose that very possibly the origin of the multitudes of varieties of cane, which are now known to exist, may really be found in a few marked kinds. On the Clarence River the ribbon cane is rapidly superseding all other varieties.

A third cane was brought from Queensland to this colony; and to this variety the planters there continue very partial; it is improperly called by them the Bourbon, which name has unluckily followed it in its introduction into New South Wales. Assuming that Wray is right, of which there can be no doubt, that the Otaheite and Bourbon are the same variety under different names, to call the cane under consideration the Bourbon is only calculated to mislead. There is no manner of affinity between them. One marked peculiarity in this Queensland cane is, the conspicuous increase in the diameter at the rings, and decrease at the middle of each internode; precisely the reverse of what prevails with the Otaheite or Bourbon of the West Indies. The right name is the Bamboo *S. arundinaceum.* At one time it was held in some little favour with a few of the farmers on the Northern rivers, who, misled by Wray's remarks, and by the misnomer, actually believed it to be the veritable Otaheite cane, and were greatly impressed with the height and girth of the stalk; but further experience has shown them their mistake; its juice, though abundant and clean, is of low comparative density; it does not stool well; and the return per acre is much below that from the ribbon; added to which it is one of the varieties

in which the disease, to which I have before casually referred, and of which I shall speak presently, has exhibited itself, so that its cultivation on the Clarence River has now for some time ceased. It has not yet been known to flower.

I now come to the dark and light purple canes. The colony owes the possession of these varieties to Monsieur Adam, who arrived on the Clarence River, from the Island of Bourbon, in 1857, and, in the following year, planted about two acres of cane on a farm of 200 acres, which he had bought at Alumy Creek, about four miles to the north of Grafton. At that time his avowed purpose was to largely extend his own plantation, as well as to supply seed "cuttings"—that is, to all who desire to follow his example. So high an opinion had Mr. Adam of these two varieties, that he persuaded every one who was growing other sorts on the Clarence to root them out and supply their places with his canes. From apprehension that he would not be able to obtain the needful labour to manufacture his sugar, and from the circumstance that a large portion of his land was flooded in 1863, and continued afterwards too wet to be cultivated, he did not carry out his original design; the canes, which had thriven well, were left uncut for three or four years, and were then burned down and ploughed out by some Germans to whom he had leased his land. Fortunately, however, before this, some farmers had been supplied with cuttings of the two kinds, so that they were not lost; and on my arrival at the river, in 1868, recognising their value, I recommended the farmers by no means to pass them by in favour of the then more popular China, or yellow Tahiti cane, as I found many among them disposed to do. My advice was taken, and both sorts were extensively planted. Previous to 1873 they were held in estimation by both growers and manufacturers. Unhappily the "disease" has attacked the dark purple variety in almost its worst form; whilst a different disease has destroyed much of the other sort known as the light purple. In consequence, they also have shared the same fate as the China and Bamboo, and have given place to the ribbon. The dark purple I believe, on the authority of Mr. Adam, to be the violet or red Belouguet of Mauritius, *S. violaceum*, and but for its being affected as above described, I should esteem it one of the most valuable varieties we possess. It has however, flowered several times, and, at least in one instance, on the north arm, Clarence River, within twelve months after planting. Of the light purple I have not discovered the name. Mr. Adam called them indiscriminately Belouguet canes. It has not yet been known to flower in this colony.

These are the canes that have been chiefly grown on the Clarence River; but I have at different times sent up a large number of sorts obtained from Java, Fiji, Brisbane, the Macleay River, and from the Sydney Botanic

Gardens. Not having been in a position to attend to them personally, they were consigned to the most trustworthy among the farmers; but, after trial, none of the varieties seemed to possess such decided superiority over the ribbon as to make it desirable to plant it in preference to that cane.

On the Macleay, however, in addition to the ribbon, there are some varieties which certainly merit notice. These were obtained by Mr. O. O. Dangar, of Kempsey, from the Fiji Islands, about eighteen months prior to my arrival on that river, in 1868. Mr. Dangar, at a much earlier period, had begun to take great interest in the industry, and to be very sanguine of its ultimate success. At that time Mr. Holland, of Port Macquarie, and Captain Thornton, of the Macleay, were almost the only possessors of sugar cane in the district, and as they were selling single cuttings at from 1s. to to 1s. 6d. a piece, he very naturally judged that the progress would be very slow. But having, while on a visit to Sydney, met the Rev. Mr. Moore, a Wesleyan missionary from Fiji, he learned from him that sugar canes could be readily and cheaply procured from those islands. He therefore, on his return to Kempsey, made arrangements for the introduction into this colony of as many well-assorted varieties of cane as, with all charges, would cost £12. Eight casks full came by the "John Wesley." The greater part of the cuttings were found to be dead on their arrival at the Macleay, but fortunately about eight hundred, of nine varieties, had survived. Of these some were sold at from 2s. 6d. to 4s. a dozen; and the remainder were planted by Mr. Dangar, from the produce of which he was able to supply most of the farmers. The canes thus introduced consist of the following sorts;—neither native nor botanical names can be given; the former, if ever supplied, have been lost; the latter are not known. I therefore give the local names:—

The Fiji ribbon is a very handsome striped cane, a rich red brown and bright yellow. This is a free-growing, upright, stout, long-jointed cane, but impatient of cold. It has no "itch," and it is easy to "trash."

The grey Fiji is a large-sized, fast-growing, upright cane, very easy to "trash," but having a good deal of "itch."

The "Black Java," in its spreading growth somewhat resembles the "light purple;" it is of a shining deep purple colour, seldom exceeding an inch and a half in diameter at the rings, which are larger than the internodes. It is very easily "trashed," and has no "itch."

The "Violet," cane is a very vigorous, large, upright, fast-growing, soft, and juicy variety, very easy to trash, but abounding with "itch." This and the grey I regard as excellent canes; and if they do not suffer from the "disease," worthy of every attention, as, if seasonably planted in properly drained and subsoiled land, and duly looked after while growing, they would

be fit to cut in very little more than a twelvemonth from the time of planting.

There are also a yellow, a green, and one or two other kinds, but none of these have qualities which call for any special notice.

In the Sydney Botanical Gardens are to be found, at the present time, seventy-four apparently distinct kinds of sugar cane, of which twenty-one were presented by myself, being the survivors of more than double that number obtained from Fiji, Java, and elsewhere; nineteen are termed "the original garden collection,"—that is to say, the names of the contributors or the source from which they were obtained has been lost. Of seven of these I am, however, in a position to speak with some degree of confidence, having the assurance of Mr. Thomas Scott that he brought them from Rioteea, in 1819, and presented them on his arrival in Sydney to the Government Botanical Gardens. Eighteen are the survivors of a much larger number brought from New Caledonia, and presented to the gardens by Mr. Caldwell, of Port Louis, Mauritius. Fifteen were obtained from Mr. W. Hill, of the Brisbane Botanical Gardens; and one from Mr. Ramsay, of Dobroyd.

(*To be continued.*)

Correspondence.

Birmingham, October 9th, 1874.

To the Editor of "The Sugar Cane."

In your April number I took the liberty of correcting some erroneous statements respecting the production of sugar in the British West Indies, which had appeared in an extract from a French periodical. At that time the official reports had not been issued; but the recent publication of those for 1872 furnishes the materials for an approximate table of the exports of sugar during the three years ending 1872.

As this may perhaps interest your readers, I enclose a copy,

And remain,

Yours truly,

C. D. Sturge.

EXPORTS OF SUGAR FROM THE BRITISH WEST INDIES (IN TONS).

	1870.		1871.		1872.	
British Honduras..		1371		1961		2203
Jamaica		24598		29608		28283
St. Kitts	9721		11362		5525	
Antigua	10140		10609		6188	
Nevis	2891		3518		1682	
Montserrat	1503		1513		1233	
Dominica.....	3660		3311		3071	
		27915		30313		17699
St. Lucia.....	5743		5767		6031	
St. Vincent.....	10382		10652		9066	
Barbados.....	31328		40530		31261	
Grenada	3880		5256		4217	
Tobago	3741		3991		4024	
		55074		66196		54599
Trinidad		40952		53592		46023
Demerara		76294		83448		71667
		226204		265118		220474

Besides the above, three or four hundred tons a year appear still to be shipped from the Bahamas; but the published reports do not give the exact quantity.

All from official returns, except the particulars for Tobago, which have been obtained from a private source.

Where the returns are given in hogsheads, these have been calculated at an average of 16 cwts. each.

SUGAR STATISTICS—GREAT BRITAIN.

To OCT. 17TH, 1874 AND 1873. IN THOUSANDS OF TONS, TO THE NEAREST THOUSAND.

	STOCKS.		IMPORTS.		DELIVERIES.	
	1874.	1873.	1874.	1873.	1874.	1873.
London	86	.. 89	224	.. 213	219	.. 190
Liverpool ..	50	.. 60	140	.. 153	142	.. 123
Bristol	4	.. 3	66	.. 63	68	.. 65
Clyde	39	.. 66	142	.. 175	157	.. 159
Total ..	179	218	572	604	586	537
	Decrease..39.		Decrease..32.		Increase..49	

STOCKS OF SUGAR IN THE CHIEF MARKETS OF THE WORLD ON THE 1ST SEPTEMBER, FOR THREE YEARS, IN THOUSANDS OF TONS, TO THE NEAREST THOUSAND.

Great Britain.	France.	Holland	Germany (Zollverein)	Six other *entrepôts.*	TOTAL 1874.	TOTAL 1873.	TOTAL 1872.
224	82	47	2	15	370	332	247

CONSUMPTION OF SUGAR IN EUROPE FOR THREE YEARS, ENDING 1ST SEPTEMBER, IN THOUSANDS OF TONS.

Great Britain.	France.	Holland	Germany (Zollverein)	Six other *entrepôts.*	TOTAL 1874.	TOTAL 1873.	TOTAL 1872.
821	250	32	297	108	1508	1450	1236

ESTIMATED CROP OF BEET ROOT SUGAR ON THE CONTINENT OF EUROPE, FOR THE ENSUING SEASON, COMPARED WITH THAT OF THE THREE PREVIOUS SEASONS.

(From Licht's Monthly Circular.)

	1874-75. Tons.	1873-74. Tons.	1872-73. Tons.	1871-72. Tons.
France	375,000	396,578	408,649	335,351
Germany (Zollverein)	250,000	288,972	258,663	189,166
Austro-Hungary	140,000	169,250	214,107	161,527
Russia and Poland	150,000	150,000	150,000	90,000
Belgium	60,000	70,366	75,978	72,236
Holland and other Countries	25,000	35,000	35,000	25,000
Total	1,000,000	1,110,166	1,142,397	873,280

STATE AND PROSPECTS OF THE SUGAR MARKET.

The month of October opened upon a sugar market of very firm attitude, though part at least of the excitement which characterised the close of September had passed away. Owing however to slightly more favourable reports from the continent, backed by some amount of pressure to sell beet, the market to some extent lost confidence, and at the end of the first week sugar might have been bought freely sixpence cheaper than at the end of last month. Continued shortness in the arrivals however, together with the otherwise strong statistical position, soon began to inspire holders with fresh hopes, and refiners have had to pay higher prices during the last week than has been the case since the abolition of the duty, being in most instances sixpence more than the extreme point reached in September. Refined, however, has been slow to participate in this movement; grocers find it difficult to anticipate any material alteration of their long experience of a falling market, and are moreover anxious not to be overstocked at the end of the year, and there are, as we go to press signs of a reaction from these causes manifesting itself in the raw market, where refiners having now provided for immediate necessities seem disposed to act with caution.

Throughout this month a noticeable feature has been the buying of raw sugar for America, both in London and Liverpool. Another characteristic which we have before alluded to, is the comparatively high price of low sugars. Jaggery has been sold during the month at 17s. 3d. per cwt.

The latest quotations of standard qualities of Raw are as follow: No. 12 Havana afloat 26s. to 26s. 6d., or sixpence dearer than last month; fair and good refining Muscovadoes 23s. to 23s. 6d., against 23s. 6d. to 24s.; middling to good brown Bahia 20s. 6d. to 21s. 6d., against 20s. to 21s. The price of common refined lump sugar is 30s., the same as last month.

Viewing the present sugar statistics, and contrasting them with former years, there would appear to be some foundation for the hopes which importers entertain of still higher prices. If the beet root results, which are speedily assuming a more tangible shape, continue to justify the present estimate of a falling off of 10 per cent., it is difficult to imagine that sugar will be cheaper, since the consumption continues to make very satisfactory progress, and there are at present few indications of a surplus importation of colonial sugar in the immediate future. On the other hand, there is no doubt that higher prices will eventually stimulate the supply.

THE
SUGAR CANE.

No. 65. DECEMBER 1, 1874. Vol. VI.

☞ The writers alone are responsible for their statements.

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NEGOCIATIONS RELATIVE TO THE INTERNATIONAL CONVENTION ON DRAWBACKS.

The following papers, from the two leading French Journals in the interest of the sugar industry, will give our readers some idea of the present state of the international sugar question and of the vacillating conduct of their Government, or rather of its determination, by all kinds of pretences and subterfuges, to escape from the obligations imposed upon it, with its own consent, by the Convention of 1864. Lord Derby deserves our thanks for the urgency with which he has pressed for a satisfactory settlement, and which surely cannot now be much longer delayed:—

The diplomatic correspondence relative to the Convention of 1864, and refining in bond, exchanged between the French and English Governments, which has just been published, and to which we made allusion last week, will be studied with profit by all persons interested in the sugar question. It is to be regretted that the origination of documents of this kind should always be reserved for England, whose diplomacy, more open or more diligent than ours, is not afraid of putting the public in possession as soon as it can, of its acts and labours. Pending the translation of this book, of which we hope there will be one, we have had to read it in the English text; so that we can only at present give an analysis of it; but our remarks, which must be confined to the principal facts, in which many have an actual and very important interest, may help to throw light upon the approaching discussion on sugar.

The situation of the white powders of our factories has been particularly the object of the representations of England, which considers that the French refiners derive a great advantage from the employment of these sugars, on which, in her opinion, a tariff is imposed inadequate to their richness, which is equal or closely approaches to that of refined. M. Ozenne, however little suspected of partiality for these sugars, the future of which, as a negociator of the Convention, he had not foreseen, objects that the French refiners only use them in small quantities, and that they are chiefly furnished to special industries, such as chocolate manufacture and confectionery. Besides, for nine years, he adds, the English refiners have not complained of their employment, which has only lately made any real progress. Mr. W. A. Gadesden, President of the Committee of English Refiners, replies, with his hands full of authentic figures, and has little difficulty in shewing that white sugars, whether indigenous or colonial, are admitted in France at a duty of 25 and 35 per cent. for the purpose of refining, to the extent annually of 100 millions of kilos., out of a total of 400 millions. Without doubt, the principle of refining in bond, if adopted by the Legislative Assembly, will put an end to premiums realised by the use of these sugars; but in the meantime the English industry suffers, and the Convention of 1864 is not loyally executed.

Placing ourselves at another point of view, we have recently shewn that white powders, far from paying a lower, were submitted to a higher duty than that on brown sugars. Our object, it is true, was to shew the use of these sugars for direct consumption, which finds unhoped-for favour with the Director-General of Foreign Trade, and which we wish to put to profit without further delay. If it be true, which no one can doubt it is, that the beautiful white powders of our factories are much sought after by certain industries, and that their consumption is increasing, is it not a reason for making a special arrangement in their favour and freeing them from the heavy tribute they pay to French refiners, whilst causing the ruin of their British *confrères?* We cannot, therefore, but fortify ourselves in our conclusions which

consist in demanding a lower duty on our own white powders which go into direct consumption. As to those destined for the refineries, as they pay in proportion to their richness, we shall have nothing to object, if the first part of our proposition is agreed to. Whilst waiting the realisation of this wish,—that which concerns white powders, in the document referred to, is highly instructive, and we cannot too strongly recommend it to the attention of all who are interested.

It is hardly necessary to say that the discussions in the National Assembly relative to the practice of the French refineries was followed with a lively interest by Lord Lyons, who daily sent to Lord Derby, the minister of foreign affairs, a letter or despatch on the progress of the question. Refining in bond is accepted, but the opposition of Belgium remains, and continues to occupy the attention of the Duke Decazes, who demands of England what situation she intends to place that country in, if she refuses to adopt the same system. The design of the French Government appears to be—to propose to England, Belgium and Holland, the revision of the Convention of 1864, and its establishment upon a new basis. While this is going on, Great Britain abolishes the duty on sugar, and new complaints, originating with the refiners, are brought forward in regard to the non-fulfilment of the Convention. M. Deseilligny, still minister of commerce, is of opinion that the abolition of the sugar duty has materially modified the situation, and asks if the Government of Her Majesty has still an interest in becoming a party to the Convention. The bounties, admitted or disguised, allowed by certain foreign nations, ought to be met in England by fiscal regulations in relation to the sugars imported from those countries.

It will be recollected that this is the theory which we formulated in regard to German and Austrian sugars; and we are happy to see that it has made its way into high quarters. But on this point, Lord Derby formally declares that the British Government is entirely opposed to differential duties, and has no desire to depart from the treaties entered into with other nations, by putting France and her products "*on the most favoured footing*."

This declaration, which cannot surprise us, and is conformable to English commercial policy, it is useful to bear in mind. It fully confirms our reservation and remarks upon the inferior systems of the sugar producing nations, with which we find ourselves in competition, and in opposition to which we can neither have the desire to play the part of dupes nor the chivalric character of a redresser of wrongs. The diplomatic correspondence also contains the petition of West India planters, and that of the Committee of English refiners, which we made known to our readers. It ends by the assurance that the system regulating refineries will be submitted to the French Council of State, at a date corresponding with the middle of October last.

Whilst all the contracting parties to the Convention on drawbacks of 1864 are vainly agitated, and trying to escape from the difficulties which can only be solved by a radical change in their respective systems of legislation, Germany is examining her sugar regime, and asking herself if the duty should not be based upon the manufactured product instead of on the beet root. A special commission of the Association of Sugar Makers of the Zollvercin has examined this question, and, with one exception, has given its adhesion to the existing system, while the legislative commission of the parliament has arrived at a contrary opinion by 8 voices against 3. The Association of Sugar Makers protests against this conclusion, declaring it to be contrary to the interests of the German sugar industry, and which is also, they state, the decision of a committee in which the different interests of the sugar industry were inadequately represented.

We shall return to this question again, but for the present all we can see is, that each country holds to its particular legislation, and will by no means rejoice over the establishment of a European sugar league. Let us add, that unanimity will be more easily attained in Germany than in France—our country—in consequence of her sugar Colonies, of her large refining industry, and her important home production,—being as she is, the classic land of sugar.

Nowhere else, in fact, are the interests which belong to this subject so divergent; and nowhere else, as a consequence, are they so difficult to conciliate.—*From "Journal des Fabricants de Sucre."*

The English Government has just published for presentation to the House of Commons, pursuant to votes taken on the 15th and 30th of July last, the correspondence relating to the Sugar Convention of 1864, and the question of the establishment of refining in bond in the refineries of France, Holland, and Belgium.

This document which contains 53 diplomatic communications enables us to understand what has passed in official regions, between the 13th February and 5th September, in the present year, and of which we propose to give a rapid analysis.

In February, the English Government, rejecting the proposition made by the French Government to assemble, in special conference at Brussels, delegates of the co-signatory Powers of the Convention of 1864, because it did not think that any practical solution would result from it, demanded that the next Commission appointed under the Treaty of Commerce of the 23rd July, 1873, which met in London at that period, should be authorised to hear observations from the English refiners. This proposition was accepted by our Government, and the Duke Decazes sent instructions to that effect to M. Ozenne, French Commissary to the next Commission.

Mr. A. W. Gadesden, President of the Committee of Refiners of Great Britain, and Mr. Martineau, the Secretary, stated before the Commission in the name of their Associates, three grievances which were but little discussed at that sitting, but afterwards expounded at length, both in notes signed by Mr. A. W. Gadesden and in reports by the agents of the Treasury and Customs.

These grievances bear upon the following points:—

1st.—The admission into the French refineries of refined sugars under the form of white powders, at a duty much below (about 3 francs) that stipulated for by the Convention.

A surtax (3fr. 18) which falls upon English refined sugar compared with that imported from the French colonies.

3rd.—The type representing the limit above the 3rd class (Nos. 7 and 9) is too high for Beet Root Sugar and corresponds to 12 or 12½ of the Dutch type, in place of corresponding with No. 10, which admits into this class a much larger quantity of sugar than it ought to do.

These three grievances, which we do not dispute are well founded, were presented at the sitting of the 23rd February, of the mixed Commission, and were set forth, as we have said, in the foregoing notes. We will, perhaps, return to this at another time. At present we pass on.

Meanwhile the question of sugar was before the National Assembly, and occupied, as our readers will remember, the 25th, 26th, and 27th, of February (see Vol. vii, p. 300).

In this discussion the Duke Decazes, Minister of Foreign Affairs, and other Members of the Government declared they were personally favorable to refining in bond; but that the stipulation of the Convention of 1864, prevented them pronouncing for the immediate adoption of that system.

At the end of the debates, from which no solution, but five amendments resulted, relating to the question of sugar, an interview took place between Lord Lyons, the English Ambassador, and the Duke Decazes, at which the two following questions were put by the latter:—

"Does England admit that she herself, and France and Holland, or any one of the three Powers, may establish the system of refining in bond, without the consent of Belgium? And is England desirous of seeing this system established?

"If yes,—What situation would Belgium be placed in if she should refuse to adopt the same system as the other Powers? Could she—ought she to be invited, notwithstanding that refusal, to take measures for putting herself, as nearly as possible, on conditions of equality with the other Powers?"

The English Government replied:—

"Relative to the first point, that it thought that no one Power

being a party to the Convention of 1864 could claim the right of establishing refining in bond without the consent of all the other Powers which have signed that Convention; but added, that it did not see any reason why this consent should be refused, and so much the more as the adoption of that system by one or more of the signatory Powers cannot compel any of the other Powers to adopt it also. For its part, the English Government declares that it not only consents, but is desirous that that system should be adopted by all the Powers, or at least by those who find its application possible; for it regards it the best means of abolishing bounties, the object which the Convention of 1864 proposed to attain.

"In reply to the second question,—The English Government did not think the establishment by France, England, and Holland, or by all three, of the system of refining bond could give to one of these Powers, or to all, the right of compelling Belgium to adopt it also. It ought evidently to be understood that any one Power who would not adopt refining in bond should continue to be bound by the Convention of 1864, and should, in consequence, take all necessary measures to conform itself to the terms, and to observe, at all points, the requirements which are at present not strictly followed."

Later on, debates took place in the National Assembly on the foregoing amendments, which led to the enactment that, from the 1st July, 1875, refineries as well as factories should be placed under the new system; and it thence became the duty of the French Government to enter as soon as possible into negotiations with the other Powers on that basis.

An interview again took place between the English Ambassador, and the Duke Decazes, Minister of Foreign Affairs. Let us see what Lord Lyons wrote to his Government relating thereto.

"To speak generally, I may say that the plan of the French Government seems to be this: To propose to England, Belgium and Holland, a revision and extension of the Convention of 1864, or the substitution for it of an entirely new one for a period to be agreed upon; to introduce refining in bond in France as soon as such a stipulation can be concluded; and, as a natural consequence, with

or without agreement with the Foreign Powers interested, to establish the system as a law which shall be binding upon her from the 1st of July or later.

"Considerable opposition was manifested in the National Assembly at the idea of establishing refining in bond in France, before it should also be established in other countries, and neither to-day nor previously, has the Duke Decazes given me any reason to believe that the French Government will take any measures for introducing the system into this country before the end of the negotiations into which it proposes to enter with England, Belgium and Holland.

"The Duke Decazes, however, does not at present make refining in bond by Belgium a condition *sine qua non* of the conclusion of a Convention to which the latter should be a party. On the contrary, he says, all that can be reasonably demanded is, that each country should engage itself towards the others to adopt all regulations which shall have the effect of placing them on an equality with itself, be an efficacious check against fraud, and a remedy against the bounties which the refiners now enjoy. If Belgium could convince the other Powers that she could compass the same end by a better system than refining in bond, whilst better accommodating herself to the particular circumstances in which she finds herself, the other Powers should consent (so the Duke Decazes thinks) that she should adopt it.

"Besides, the Duke Decazes expressed to me his intention of instructing the French delegates, at the opening of the Conference, to present a project of a regular code of regulations for observance in the system of refining in bond. He regarded this as essential, because, according to the way each might be bound, the system might prove to be very nearly a perfect protection against fraud, or be altogether illusory. He has, consequently, named a Commission to prepare the project, and he does not desire to enter upon negotiations before it is ready to be submitted to the delegates.

"I observed to the Duke Decazes, that such a Commission usually proceeds slowly, and asked when he hoped the project

would be ready. He said that some weeks, at least, would be required to prepare it.

"I replied, that I ought to remind him that during all the time required for preliminary measures, France would remain exposed to the imputation of eluding the punctual execution of the Convention of 1864.

"The Duke answered that he quite understood that the correlation provided for by the treaty did not yet exist in France, but that refining in bond would be the means of establishing it.

"I said that refining in bond seemed to me not only the best, but the only efficacious mode of attaining the object of the Convention; and that it was for that reason I considered its introduction into France, with the shortest possible delay, a question of good faith, as well as good policy."

The despatch of Lord Lyons to Lord Derby is dated the 31st March.

In April, Mr. Kennedy is sent on a mission to the French Government, and specially charged to follow up, in conjunction with Lord Lyons, not only the discussion relative to the three grievances presented, as above, by the Committee of the English Refiners, but to acquaint himself with the project for regulating the practice of the refineries, which ought to be communicated to him according to the promise made by the Duke Decazes to Lord Lyons.

In reading the despatches which Lord Lyons and Mr. Kennedy addressed to their Government from the 14th of April to the 28th of August, we confess we cannot help feeling a kind of wounded national pride, not that these documents are wanting in the most perfect urbanity, but that the simple exposition of facts reveals a situation which very nearly resembles that of an insolvent debtor in presence of the just reclamations of his creditors, when only seeking to gain time, and raise incidental questions, in place of "taking the bull by the horns," as the saying is, and bringing the matter to a conclusion loyally and promptly.

To-day, the time for deferred payments appears past, while the round of discussion becomes narrowed. One may judge so by the following despatch of the 28th addressed by Lord Lyons to Lord Derby:—

"I spoke yesterday to the Duke Decazes in the sense of your Lordship's despatch, dated the 20th current, concerning the question of sugars.

"I reminded him that, after having herself proposed to Great Britain, Belgium, and Holland, an arrangement having for its object the mutual abolition of bounties on exportation of sugar; after having entered, in 1864, into a formal Convention with those Powers, even binding herself with them; after having seen Great Britain execute the stipulations of the Convention punctually and scrupulously—she, France, had eluded those stipulations for nine years, and recently, by augmenting the duties on sugar, had further proportionally augmented the excess of the drawback accorded upon the duty actually paid, and had thus, in fact, increased the bounty on exportation.

"During all this time, I said, Great Britain has made strong efforts to obtain from France the loyal execution of the Convention of 1864; and I added: I am instructed to-day to make pressing representations to you on the existing state of the question.

"I then made known to His Excellency the observations contained in the despatch of your Lordship; then I expressed the firm hope that at the meeting of the next Commission, which should be held in London next month, the Government of Her Majesty would see the French Commissioner declare for the prompt and complete execution of the Convention, and the immediate application of refining in bond.

"The Duke Decazes replied that the present French Government would have been happy to carry out the complete execution of the Convention of 1864, if that had been in its power, but the correlation required by the Convention could not be established without a legal enactment, and after having attentively examined the question the Government have acquired the certainty, without any doubt, that it would be impossible to induce the National Assembly to pass such an Act.

"Nevertheless, the Assembly (the Duke came to tell me so), in deciding upon the introduction of the system of refining in bond, has provided a much more efficacious method of attaining the object

of the Convention than by the literal execution of its stipulations.

"The Government has, besides, made a great step in the way of necessary preliminary measures for the establishment of refining in bond. The efficaciousness of that system must naturally depend upon the measures of detail adopted for its application. If these measures are badly conceived, the system must, in practice, be entirely illusory; and, on the other hand, the application of the system, for the first time, in the sugar refineries spread over all France, is not a simple question. The Government has, nevertheless, already, entirely completed a code of regulations on this subject, and sent it, as is necessary, to the Council of State. This body is at present "*en vacance*," but will soon meet, and we hope it will be able to give its attention to this regulation towards the end of next month.

"The Duke came to tell me that it was his intention to communicate this arrangement to the Government of Her Majesty as soon as it should be definitely settled, and he hopes to be in a situation to do so as early as October.

"In that which concerns the execution of this regulation, a question arises, viz.: Can it be applied without the express orders of the National Assembly? In support of the affirmative, it may be said that, in laying upon the Executive Power the obligation of establishing the system before a fixed date, the Legislature implicitly conferred upon it the right of determining upon all practical measures required for carrying it into operation. The Duke hoped that this way of viewing it might be judged correct, and that the Government would be capable of putting the plan in execution on its own authority from the moment it is ready. It must be confessed, however, that serious doubts are raised in his mind as to the right of the Executive Power to apply restrictions, and levy the necessary penalties, unless the latter were expressly imposed by an Act of the Legislature. Although this may be so, the Duke could assure me that the Government would apply refining in bond as soon as it should acquire the means of doing so.

"I asked the Duke Decazes if the sentiments he expressed, were also those of M. Grivart, Minister of Commerce, and

M. Matthieu Bodet, Minister of Finance, who have entered upon their duties since the discussions on the Sugar Law commenced in the Assembly.

"The Duke Decazes answered that, without doubt, his two colleagues partook entirely of his sentiments. I begged him then to communicate to them, without delay, the observations I had made to him, and, in order to enable him to do so, exactly and completely, I left with him, at his request, some written notes, recapitulating the despatch of your Lordship.

"In conclusion, the Duke Decazes authorised me to assure the Government of Her Majesty, that the desire and determination of the French Government were to establish refining in bond *(l' exercise des refineries)* as soon as it could be done."

At last, in a memorandum drawn up by Mr. Lee, Secretary for Great Britain, after the close of the discussion on the Sugar question, which took place at the sitting of the mixed Commission, held in London the 5th September, the following statement is recorded: "Mr. Kennedy refers to communications which have been exchanged between M. Deseilligny, then Minister of Commerce, M. Ozenne, M. Meurand, and himself, and more especially to the promise which was made of communicating to him for the Government of Her Majesty, the "project of regulation" which the French Government proposes to adopt, on introducing the system of refining in bond, into the refineries of France. Mr. Kennedy also calls attention to the communications recently exchanged between Lord Lyons and the Duke Decazes, and demands of M. Ozenne what communication he has now to make to him on that subject.

"M. Ozenne repeats in substance the communication made by the Duke Decazes to Lord Lyons, and adds, that this regulation shall be taken into consideration by the Council of State, of which he is a member, as soon as it meets after the present vacation, that is to say, after the 15th October."—*From "The Sucrerie Indigéne."*

The approaching meeting of the Assembly is drawing attention to the sugar question, and we learn that a long Conference was recently held in the office of the Under Secretary of State, M. Pasey, at the Ministry of Finance, upon that subject. All the heads of the service interested in this question were present: M. M. Ozenne, Secretary general of the Ministry of Commerce; Amé, Director-general of Customs; Provensal, Director-general of indirect taxes; Audebert, under Secretary to the Secretariat, and several inspectors of the finances. They took cognizance of our last Diplomatic Convention of 1864 with England, Belgium, and Holland. They recalled the animated debates which this difficult question, raised by M. Pouyer-Quertier, provoked in the National Assembly. The Chamber had decided that a sum should be entered in the budget commencing from the 1st July, 1875, to represent the anticipated receipts from refining in bond. No such sum has been fixed upon, and it was the execution of that resolution which was one of the objects of the deliberations of the Conference. We may add that not only has the Chamber not voted means for the material execution of the projected system, but it has not decided upon the bases of the new mode of impost. The arrangement of the public administration by which this point is to be settled must have the importance of a law, and we do not know whether the Administration has the power to establish it. It will be necessary, in fact, to ascertain if the impost is to be established upon one or more types; if the white powders of the factories are to retain, as that appears to us indispensable, the moderate privileges they now enjoy; finally, what ought to be the bases of international commerce in sugars, and what arrangement is to take the place of the Convention of 1864, which expires on the 30th of June next. All these questions have an extreme gravity.—"*Journal des Fabricants de Sucre*," *November* 19*th*.

CENTRAL FACTORY FOR JAMAICA.

Our esteemed correspondent, Mr. Richard Henry Burton, who was was commissioned from Porto Rico to visit the "Usines," or central factories of Martinique, in 1872, and whose report has been printed in a supplement to the *Jamaica Gazette* of October 8th last, under sanction of the Governor, is now engaged in the formation of Company which it is proposed to call "The Jamaica Central Sugar Factories Company (Limited)," and has issued the following preliminary Prospectus :—

"The object for which this Company is formed is to introduce and carry out in Jamaica the system of Central Sugar Factories successfully carried out in the French Islands and elsewhere in the West Indies. It is proposed to acquire lands and machinery and possess means of transport by land and water. Railways will be necessary for easy land carriage and where factories are established near the sea, one or more steamers or steam tugs may be profitably owned and employed plying for passengers and freight when not on the Company's special service.

"Until the system of separating the Manufacture of Produce from growing the cane was understood by the body of the people, it might become necessary for a factory to enter on planting and agricultural operations, in which case it might be desirable to adopt the more advanced method of cultivation by the aid of steam-ploughs, and other improvements, an example which would not fail to be of general benefit to the Island.

"The co-operation of home capitalists, without which the work must be circumscribed, can best be secured by the Jamaicans themselves evincing confidence in enterprises of this nature in the colony giving varied employment to its inhabitants and leading to the circulation of large sums of money.

"The local duties for the importation and exportation of sugar in and from Jamaica and freight and charges will be saved on a better class of sugar for island consumption by producing it in the country. In Great Britain since the abolition of the sugar duties

the produce of foreign refiners has materially affected the ordinary muscovado.

"Many of the Martinique usines or factories average a profit of 25 per cent and upwards. The small English island of Saint Lucia with only 30,000 inhabitants is to have its central factory.

"An advantage of profit to a Jamaica sugar estate is always its spirit, well known as Jamaica rum, and this staple will also receive more careful attention on the factory system than it can receive at present.

"The chief office of the Company will be in

"In case of no allotment being made the deposit will be returned without deductions, and in case of any less allotment than the number applied for, the surplus deposit will be applied so far as required in payment of the amount due on allotment."

"Capital £18,000 in 3600 shares of £5 each. Deposit on application £1 per share, and on allotment £2 per share. A call six months afterwards of £1 per share, and calls, at intervals thereafter, not exceeding 10s. per share (with power to increase the capital and extend the number of shares)."

In a previous circular, addressed to his friends, Mr. Burton says :—

"In an island where it is admitted there are 5000 small mills of the most primitive kind in operation, the establishment of central factories would be a boon highly appreciated by the owners of these, and would conduce greatly to the wealth and general prosperity of the island, opening a field for intelligent labour, and the employment of a number of artisans who at present find a difficulty in obtaining it."

In a future issue we shall probably submit to our readers Mr. Burton's most interesting and able report on the Martinique usines. In the meantime, we take the following from *The Colonial Standard and Jamaica Despatch*, of October 15th :—

"We have much pleasure in directing attention to the able and instructive paper on central factories by Mr. Burton, now being republished by us from *The Gazette*, by authority, under saction of His Excellency the Governor. All who feel an interest in the

vital question of the introduction of the useful establishments named in this island will find in that report something whereby to test the objections which may be floating about them on the subject. It is believed here that the large proprietors who have expensive works already settled on their estates, will not generally consent to throw them up, for the purpose of combining to have have one common factory for the manufacture of their canes. The same difficulty appears to exist in Martinique, the place which is par excellence, the exemplar of the central factory system. These large establishments still continue there to carry on upon their own resources. With regard to the small estates, the lack of capital, the want of unanimity, and the difficulty of adjusting proportionate advantages, fixing the locality so as to please equally every pretender, and the proportional shares of expenses and profits prevent their combination; but a central factory adroitly placed in a favorable locality soon tempts the planters to take advantage of the superior machinery placed within reach. By degrees the owners of those small estates find it to their advantage to sell their canes to the usine, and cease to manufacture sugar. But, as Mr. Burton says, the support of the estates is not essential to the success of a central factory. The establishment once settled in a favourable position causes canes to be grown where none were grown before. Most of the Usines in Martinique were established with this view, and proved great successes. The big estates continued to make sugar according to their own way; the usines manufactured sugar from canes grown by the small cultivators, who increased in number as the means of turning their labour to good account thus became easy to them. The effects to the island generally were of course very beneficial. The exports of sugar nearly *doubled*, and being of superior quality, giving no loss by drainage to shippers or purchasers, the proportional market value was greater. The shipping towns profited by this increase of commerce. The benefits direct and indirect to all classes soon were felt. Among the ascertained advantages enumerated by Mr. Burton, he mentions:—'The increased means of lucrative employment for skilled labour; increased profits to the

artizans, smiths, masons, carpenters, &c.' All find constant employment in and about the factories, whilst the large circulation of money brings prosperity to everyone. The Revenue too has profited by the general increase of wealth. The exports have doubled, and so have the imports as a necessary consequence."

"The results of the usines as speculations have been also most encouraging. Fifteen usines, representing a capital of £860,000 were in operation up to the year 1872. Of these, seven were owned by limited liability companies, six by anonymous associations, and two by private hands. All paid handsomely; the net profits on capital averaging from 27 to 48 per cent. per annum.

"Here then are facts, which establish the central factory system as one peculiarly suited for adoption in this island, as a pecuniary speculation. Whether the physical conditions existing here are favourable or not, is a matter which we shall endeavour to deal with in another article—simply expressing our opinion in the affirmative for the present.

"Mr. Burton, it will be remembered, has issued circulars with the view of forming a Company here for the establishment of a pioneer central factory. The paper above referred to was written by him as an official report on the system as conducted in Martinique, which he was commissioned to observe for the benefit of Porto Rico. This report submitted by him to our Governor, has been published in an official paper by order of His Excellency. Every one who peruses the report will discover at once, that it is the production of a master mind, well versed in the subject of which it treats, and who may be considered as eminently capable of striking out the right course in settling a central factory here. We hope Mr. Burton will meet with sufficient response from the public to induce him at once to put forth his prospectus, and to see to the beginning of operations."

HISTORY OF THE SUGAR CANE IN AUSTRALIA.

(Paper read by Mr. Melmoth Hall, at a Meeting of the Agricultural Society of New South Wales, under the Presidency of Sir Hercules Robinson, K.C.M.G.)

[Concluded from page 597.]

It is a matter of much concern that both climate and soil are so entirely unsuitable for these plants that, not only has a large proportion of the canes presented by Mr. Caldwell and myself died, but of the remainder, many are in a very sickly and precarious state. I hope, at the proper season, to be able to send up cuttings of all the varieties to the Clarence river, so that at least they may be preserved to the colony.

Among the canes obtained from the Brisbane Gardens is one called the Salangore. Wray pronounces this to be "perhaps the finest description of cane in the whole world." Dr. Icery, however, in his report presented to the Mauritius Chamber of Agriculture, on the 22nd September, 1868, speaks of it as inferior to both the white and red Belouguet and the Diara. Be this as it may, I do not think we have the true Salangore any more than the true Otaheite in the colony. Wray describes it as "remarkable for the quantity of its cane-itch, having leaves of a darker green than those of the Otaheite—very broad, drooping considerably, and deeply serrated." The colour of the cane unfortunately is not given, but he says, "it is named tibboo cappor—the chalk cane—from its sometimes having on the stalk a white resinous substance, and that on any fair land it attains an extraordinary size and height." Now we certainly have no cane in the colony which answers this description. I hope shortly to be able to make another attempt to obtain both this and the Tibboo Leeut, or Otaheite cane, from Java.

The following is an interesting fact in connection with the early introduction of the sugar cane into this colony:—Mr. John Crispin, of Carr's Island, Clarence River, was gardener in 1850-51 to Captain King, of the Australian Agricultural Society. I have it on his authority that in the garden at Port Stephens he had a brown sugar cane, which grew like a bamboo, a foot in girth, and twenty feet high. This cane resembled one he obtained from Mr. Rudder, of Kempsey, in some respects, who called it the "Salangore" cane. The plant, from a portion of which this grew, was brought to Port Stephens by a coloured man who was working on board a whaler, and who exchanged it for a bag of lemons. Unfortunately this is all the information I have been able to acquire, as Mr. Crispin left the Australian Agricultural Society early in 1852, soon after which the whole of

the premises were consumed by fire; it is to be feared that the cane was destroyed at the same time, as no such cane is to be found in the colony now. There can be no doubt that it was brought from one of the Polynesian groups; but which, is matter only for conjecture. But the knowledge that such a sugar cane exists ought to stimulate into activity the search for all the best varieties. A missionary in this city, of whom I had an opportunity of inquiring, assured me that in the Fiji Islands he had seen sugar cane fully equalling in dimensions that just described.

FLOWERING OF THE SUGAR CANE.—Having in the course of this treatise alluded several times to the flowering of different varieties of cane, I take occasion to say that much misapprehension prevails in this colony upon this subject. It has been asserted that, within the tropics, all sugar canes without exception, after lapse of a certain number of months, arrow and flower. That is a mistake. Dr. Icery, in his report previously referred to, gives a list of canes which flower, and of those which have never been known to flower in Mauritius. It has also been repeatedly affirmed that one of the great features in the temperate climate of this colony is, that here no variety of sugar cane ever flowers. This shows the danger of asserting a principle on insufficient data. The sugar cane seems to flower here quite as freely as I have ever known it flower in the East Indies; and the flower seems equally unfruitful. On a number of occasions I gathered the blossom tufts myself in various stages of forwardness, and sent them to Mr. Chas. Moore, of the Botanical Gardens, for microscopical examination. In no case did the most careful examination result in the discovery of a single seed, ripe, or unripe. I am the more desirous to impress this fact strongly on your notice as, in one of the numbers of the *Barbadoes Agricultural Reporter*, quoted in the *Produce Markets Review* of September 18, 1869, a Mr. Drumm writes to say that the seed, which he describes as "single, oblong, and pointed, and ripening in the flower," has been obtained and sown, and "that vigorous transparent canes have been produced from them." Strange, if such be the case, that for nearly five years nothing more should have been said about them. The editor of the *Produce Markets Review* naively suggests that "plants of the dozens of varieties which grow wild in Queensland might be imported into some place in the colony of Victoria for the purpose of trying experiments in hybridisation." I do not myself happen to have heard of a single sugar cane being indigenous in Queensland; nor do I know what part of the colony of Victoria is so eminently suitable for sugar cane growing, nor what object would be served by removing the "wild canes of Queensland" there in order to conduct the experiments. Acquaintance with Australian geography is manifestly not at its zenith at home.

DISEASES OF THE SUGAR CANE.—I now come to a very important part

of my subject—namely, the diseases affecting the sugar-cane in this colony. In July, 1869, I first observed in a cane field at Southgate, Clarence River, many of the stalks and parts of the leaves enveloping the canes partially covered with a white, downy substance, interspersed with black, streaky patches. Finding this very prevalent, and apprehensive of serious consequences if allowed to extend unchecked, I sent down some of the infected canes to Sydney for examination and report. These were put into the hands of Dr. Morris, who, on the 13th of August following, read before your journal and scientific committee an able paper, showing that the white substance was filled with a species of coccus in various stages of development, the black patches consisting of fungus. Dr. Morris suggested the remedial employment of lime united with carbolic acid as a manure, and sulphur applied to the stems and leaves, as is done to the vine to protect it from oidium. He also recommended drainage of the land. Since 1869 I have not heard of this blight having again appeared. If I remember rightly the field was planted with both ribbon and dark purple canes, and both varieties were alike affected.

The disease, popularly but incorrectly called "the rust," seems to have attacked indiscriminately all the varieties except the ribbon and china. I have not heard of any case in which injury has occurred to either of these. So far as has yet been discovered, it in no way resembles the "rust" which appears in wheat—*Puccinea graminis;* there is no dust or powder on the leaves; they become blotched with a red colour, and the stalks soon after become dry and withered; nor have any insects been detected under examination with a powerful microscope. In this colony the disease was first observed on the Richmond River, but immediately afterwards it was noticed on the Clarence. The varieties which have suffered most are the dark purple and the bamboo. It is a noticeable fact that ratoons springing from diseased canes which have been cut, seem perfectly healthy up to a certain time or period of their growth. Would not this seem to indicate that the season has something to do with it? In Queensland, where it has appeared and excited much apprehension, opinions are divided as to its cause or origin, one party attributing it to want of efficient drainage, another stating confidently that it has appeared in cane planted on the best drained lands, while, on cane growing in an undrained clayey bottom, it has not been detected. But, so far as I understand, the last-named cane was of the ribbon variety, which, no matter where planted, has hitherto escaped attack; while by "best drained lands," I believe, is meant only lands where there is what is called "good natural drainage." My own opinion is, that deep through drainage, subsoiling, and the application to the soil of an ample supply of lime, would greatly diminish all this class of diseases, at least on the Clarence.

Another kind of disease has exhibited itself in the light purple cane, and seems peculiar to this variety. At all events, it has not been yet detected in any other. The canes, to all outward appearance, are healthy; but on examination the stalks are found shrivelled and hollow, and what little juice remains is devoid of a particle of sweetness. It would have been very interesting to have communicated with Mauritius, in order to compare the foregoing diseases with the "degeneracy or sickness of Flacq," which has actually destroyed so many of the very best varieties of cane in that island; but of course this has been impossible.

Trashing.—Few matters connected with the cultivation of the sugar cane have caused more controversy among men professing to be authorities, than whether it be or be not advisable to "trash" the plant; that is, to remove the withered leaves—in many cases already partially detached—from the cane during their growth. It has been asserted that the practice is unknown in Antigua or generally in the West Indies; indeed, even the meaning of the expression has been referred to the removal from the fields after the canes have been cut and trimmed of the "long tops" and field trash preparatory to "hoeing." It may not have prevailed in Antigua sixty years ago; but, admitting this, Antigua is a very inconsiderable part of the West Indies. Nor is the practice of half a century ago to be taken as a guide to what prevails now. But, to show the mistake of the assertion so far as relates to the West Indies generally, Wray, writing in 1848, says—"Planters are very much in the habit of planting canes too closely together, which again leads them on to 'trash' those canes too heavily." In speaking of Demerara, he condemns "the non-practice of trashing," attributing to it, and "the manner in which the canes are allowed to run along the ground, the very poor quality of their cane juice." While, still earlier, Porter speaks of its being advisable, under certain conditions, to "take off the decayed leaves from the cane that the plant may receive the unintercepted rays of the sun." It has been argued that in this colony the slight frosts which occur make it undesirable to strip off the withered leaves, as they afford protection against the injury which would result from the cold were they removed. But this I believe to be a fallacy. The leaves at their juncture with the stem retain moisture in considerable quantity, upon which frosts act much more injuriously than they can upon the bare dry cane, in addition to which they harbour insects and increase the tendency of the plants to "spring," or throw out side-shoots; besides, it is the leaves and unripe tops which suffer from frost, not the ripened stalks. Canes, too, are not unfrequently thrown down by wind—"laid," as it is technically called; if, in such cases, they have had all the withered leaves stripped off while still standing, the injury they suffer from their prostrate position is inconsiderable; while if untrashed, the deprivation of air, light, and heat soon renders them worthless. In the *Sydney Mail* of the 14th June, 1873, an interesting letter

on this subject is inserted, from Mr. J. M'Donald, of St. Helena, Queensland, which appeared originally in the *Queenslander*. In this the difference resulting from trashing and not trashing is plainly set forth. Mr. M'Donald says in 1870 he had four acres of ribbon cane, ten months old fourth ratoons, crushed at the Government plantation, St. Helena; of these, two acres were trashed and two untrashed. The density of the juice from the trashed cane was 10° Baumé: that from the untrashed, 7° Baumé. The yield of sugar from the trashed cane was at the rate of a little more than two tons to the acre; from the untrashed cane just half the quantity. The cane was grown on very rich, scrub soil, planted 6 feet by 3 feet; it was very rank, and there was a very large quantity of trash on the cane. He adds that, "after five years' experience, he finds that sugar cane will not ripen well with the trash on." The canes must be trashed at some time or other previous to their being carted from the field for the purpose of manufacture, and surely it must be better to do this work at the grower's leisure, while the canes are still standing in the field, than to delay doing it until be has his hands full. The Sugar Company, however, after four years' practical experience, have so far decided the point at issue that they make it one of the conditions for all farmers competing for the prizes they offer that their canes shall be trashed three times.

Best Time for Cutting the Cane.—The best time for cutting the cane has been variously stated. Some have argued, from the fact that fruits ripen for the most part in the autumn, that the cane should be cut at that season rather than in the spring, when it begins to grow, according to the prevailing practice. But there is no analogy between the two. No resemblance exists between the sugar cane, the saccharine matter of which is found in the sap, and fruits, which are, as it were, envelopes containing the seeds of their respective plants. Moreover, fruits ripen about the same time of year, whereas the process of coming to maturity of the sugar cane is one of continual progress. The sugar in the juice of the cane owes its elaboration in a very important degree to the leaves; as soon as a leaf naturally withers no more sugar can be formed in the internode, to the node, or ring, immediately above which the leaf was attached; and the question of ripeness—that is, fitness for being manufactured—resolves itself simply into one of quantity or length of cane, the leaves of which have died, depending, however, always upon the season, as continued wet and absence of sunshine materially reduce the yield of cane or crystallizable sugar; and this seems a sufficient answer to the advocates for autumn and winter, in preference to spring and summer, cutting. At the former season light and heat are continually decreasing, if wet be not on the increase, till they reach their minimum in June; while, at the latter, light and heat are continually on the increase, till they reach their maximum in December; while the wet is seldom excessive during the summer months. The following table,

computed from reliable returns extending over the last four years, and embracing the Clarence and Macleay Rivers, though by no means to be regarded as setting the question at rest, may at all events be regarded as an approximation to the truth, though the experience of after seasons would perhaps be found to modify the results. It exhibits the mean density of juice of all kinds of cane as indicated by Baumé's saccharometer, for the four years from 1870 to 1873, both inclusive:—July, 9·27; August, 9·41; September, 9·33; October, 9·6; November, 10·1; December, 10·5; January, 10·42; February, 9·74; March, 8·93.

It will be observed that, excepting for the months of August and September, which ought to change places, there is a progressive increase in the density, culminating in the highest mark in December, from which month it begins to retrograde, until, in March, it is at the lowest. And this is easily understood when it is considered that the month of January is not only a very hot, but a rainy month, stimulating active growth in the canes, and decreasing the richness of the juice.

Assuming the correctness of this table, it appears that the manufacturer would profit by commencing operations in August or September, and ceasing in January or February; but the growth of the ratoons has to be taken into account, and to delay cutting the cane beyond December would unquestionably imperil them, and risk material injury to the grower. I have therefore no hesitation in expressing my opinion that, all things considered, the best time for cutting the cane is, as is now done, between the months of July and December.

Disposal of Produce.—The bulk of the growers on the Clarence River, with a few inconsiderable exceptions, dispose of their cane to the Colonial Sugar Refining Company, who cut it in the field, cart it to the river bank, and convey it thence to the mill in punts drawn by a steam tug. The grower receives 10s. per ton for his cane all round, irrespective of the density of juice. This plan undoubtedly has its defects, as it encourages the farmer to grow heavy crops of cane, without having regard to its sugar-producing qualities. But practically there is no remedy. The large mills require from seven to ten tons of cane an hour, and work night and day; this will explain the impossibility of separating the cane of one grower from that of another. The plan originally contemplated by the Sugar Company was to pay for the cane on a scale proportionate to the quality of the juice—1s. per degree of Baumé saccharometer, commencing at 8 degrees. These were the terms offered to the farmers by myself, on behalf of the company, in 1868. But the plan was found impracticable, and it was abandoned for the simpler, though to the purchaser less favourable, arrangement of 10s. per ton for all qualities; and the objection is met by the very liberal prizes offered by the company to the farmers who are found to have taken most pains in the cultivation of their crops of canes.

Weight of Sugar per Acre.—In my lectures to the farmers on the Clarence and Macleay Rivers in the years 1868-69, I repeatedly referred to the large returns which, with high farming, might be expected from their splendid soil. I set this down as not falling short of 100 tons to the acre, a quantity so unprecedented as to be regarded not only as in the last degree visionary, but out of all reason—in short, impossible.

The following statement of the yield of cane, as weighed and paid for, cut from land the accurate measurement of which may be implicitly relied on, will exhibit what has been done—not, be it remembered, with high farming, but by only keeping the soil free from weeds and well stirred, and the plants properly trashed—and will serve as at least a guide in estimating what may be fairly expected to result from through draining, subsoiling, liming, and irrigation.

Yield of Plant Cane, grown by farmers in the year 1873, on the Clarence River, above Laurence.

Name.	Locality.	Acres.	Tons of Cane.	Produce per Acre. Tons.
C. Thorley	Ulmarra	2½	168	67
D. Cameron	Great Marlow	2½	150	60
J. Whitton	Ulmarra	2¾	163¼	59
H. Miller	Ulmarra	5½	309¾	56
W. Lee	Ulmarra	4½	235	52
		17¾	1026	mean 57⅘

Yield of Plant Cane, grown by farmers in the year 1873, on the Clarence River, below Laurence.

Name.	Locality.	Acres.	Tons of Cane.	Produce per Acre. Tons.
R. Rankin*	Chatsworth Island	2¼	169	75
W. M'Pherson	Waregah Island	3	215	72
N. Fraser	Chatsworth Island	4¾	311	65
K. M'Millan	Harwood Island	2¾	177	64
A. M'Aulay	Harwood Island	7¼	448	62
R. Rankin	Chatsworth Island	6¼	385	61
A. M'Donald	Waregah Island	4½	272	60
M. M'Kay	Palmer Island	6¼	366	58
G. Martin	Harwood Island	3½	200	57
J. Rolens	Harwood Island	2½	137	55
Ludwig Laufer	Harwood Island	2¾	147	53
Farquharson Frazer	Chatsworth Island	7¼	370	51
		53	3·197	mean 60⅓

* This farmer has partially through-drained and limed his farm,

Yield of One Year Old Ratoons, grown by farmers in the year 1873, on the Clarence River, above Laurence.

Name.	Locality.	Acres.	Tons of Cane.	Produce per Acre. Tons.
R. Donoghue.....	Southgate	4	151½	38
D. Munro	Clarenza.....	7½	277½	30
J. Gregor	Clarenza.....	4	117¼	29
H. M'Lachlan	Great Marlow.....	4	113½	28
		19½	609¾	mean 31

Taking the plant cane both above and below Laurence, seventeen farmers had among them 70¾ acres, which yielded 4223 tons of cane, or 59⅔ tons per acre. All this was cane of the ribbon variety, and though it had on the whole been well trashed and otherwise attended to, except in the single case of Robert Rankin, who heads the list, none of those operations had been put into practice which would naturally be expected to materially increase the yield.

From this table it will be seen that two farmers, having 5¼ acres between them, cut each over 70 tons per acre; seven farmers, having 30½ acres between them, cut each over 60 tons per acre; and eight farmers, having 35 acres between them, cut each over 50 tons per acre. Previous to the year 1873 the greatest weight cut from any one field was 58½ tons to the acre; so that there is a marked improvement in that season. And, as an evidence of the steady continued yield, when any fair amount of care is bestowed on the cane, H. M'Lachlan, whose name appears as having cut 113½ tons of year old ratoons from 4 acres of land, cut from the same field 113 tons in 1872, and the year before, when they were two years old plant canes, 225½ tons.

Proposed Method for Largely Increasing the Yield.—In my instructions to the farmers on the most approved mode of cultivating their lands for sugar cane, I was compelled to respect their prejudices, their indisposition to try any new plan, their somewhat contracted adherence to accustomed though antiquated systems, and, above all, to their impecuniosity. To this is owing that I did not insist more on the necessity of through draining, subsoiling, and liming. I did more than hint that if they wished for good crops they would neglect none of these operations; but the almost universal quiet opposition that I met sufficed to convince me that it must be left to time to work the alteration in their habits, and that meanwhile the amazingly fertile soil of the river banks must alone be depended upon. Now, however, after many days, I am beginning to find the bread I cast upon the waters. The sugar cane fields are not now so much disfigured with stumps. It is true that subsoiling is yet a thing of the future; but through-draining has made a start, and liming also—here a little and there a little. I will now take a step in advance, and show what method I should

pursue to largely increase the yield. I fully expect it will follow the fate of my recommendations of 1868-1869, but some enlightened man may be induced to try the experiment on a small scale; and the small end of the wedge once inserted, I have no fears that it will not soon be driven home.

The plan is this: Adopting a modification of the Lois Weedon system of tillage, instead of planting the canes in the first instance 7 feet by 7 feet, I would plant them 14 feet by $3\frac{1}{2}$ or 4. Midway between the rows let a trench 2 feet broad and 2 feet deep be ploughed and dug; into this trench all the field-trash must be deposited, and as much mill-trash as can be obtained. It ought all to be returned to the soil. I speak as a cultivator. None of it ought to be used as fuel. The effects of burning, instead of applying it as a manure, cannot fail of being soon felt, and then farewell to all hope of a repetition of 75 tons to the acre! Over each layer of dead leaves a small quantity of earth should be thrown, and, when the cane has been cut, instead of leaving the roots to spring up from the partially exhausted and deteriorated soil in which they have been growing during the preceding twelve or fifteen months, remove them into the trench prepared for them, and cover them immediately with two or three inches of soil; if too large, they should be divided, and used for extending the plantation, and thus the ratoons will always have fresh and rich soil to spring up in, and instead of a multitude of spindly canes, growing, as is now the case, in impoverished soil, they will be all stout and vigorous, and no fewer in number; and the land will be maintained in all its pristine richness and "heart," as the farmers call it. If the plough be first run down one side of the cane roots as close as possible to them, and be then taken down the other side, and under them, they may be turned up without much difficulty. By pursuing this method, always premising that the land has been in the first instance through-drained and subsoiled, is there much room for doubting that the 75 tons of Mr. Rankin will be increased to the larger amount I have named as the expected yield from an acre? and that not from a small and select part of one farm, but from the whole of all the farms where the plan is carried into operation.

That this industry is now fully established on a substantial basis, is an incontrovertible fact. Mr. Scott's repeated assurances have been amply verified. And, for myself, I still look forward with confident expectation, if it please God to spare my life, to a time when the cane growers of this colony will have it in their will, as in their power, to follow my advice to carry on all those operations which are essential to "high-farming," and may then discover that my assurance, that a day would come in the bright future when they would be able to cut 100 tons of cane from an acre of land, was not the empty boast of a mere visionary enthusiast, but a sober reality.—*Sydney Morning Herald.*

NOTES UPON ANIMAL CHARCOAL.

THE PRESENCE OF FERROUS SULPHIDE IN CHAR.

By Robert Frazer Smith, F.C.S.

From "The Chemical News."

All chemists usually state the total sulphur in char as calcic sulphate, even when the sample is from an old working stock. When any notice is taken of sulphides they are generally reported as calcium monosulphide. It appears to me that ferrous sulphide is always the sulphur compound present, and not the calcium sulphide. The latter occurs in new char in exceedingly minute quantity. All the calcium sulphides are soluble in acetic acid with evolution of H_2S.

Anhydrous ferrous sulphide is not in the least affected by this acid, but with HCl, however dilute, at once evolves H_2S. The majority of chars when boiled with glacial acetic acid (free from mineral acids) fail to yield the faintest trace of H_2S. If now the residue from the acetic acid be washed and HCl added, H_2S will come off in abundance.

Expt. 1.—A mixture of calcic sulphate and lamp-black, heated in a crucible to a full red heat, on cooling was treated with acetic acid. The whole of the sulphides were decomposed by the acetic acid, and HCl failed to evolve any more H_2S from the residue.

Expt. 2.—Powdered recently prepared iron sulphide was boiled with glacial acetic acid, but no H_2S was liberated. It would therefore appear that the iron, and not the lime compound, is what we have to deal with in char.

It is undoubtedly the case that the sulphur is produced in the revivification from calcic sulphate at the expense of the carbon, but the sulphur transfers itself at once to the iron. The following are the amounts of sulphur stated as such in three working stocks from well known and successful sugar refineries in various parts of Britain. The iron is also stated for comparison.

	I.	II.	III.
Sulphur	0·15	0·19	0·27
Iron	0·43	0·24	0·71
Calcic sulphate..	0·33	0·51	0·17

An attempt was made to find out in which grist of char the most free sulphur (or ferrous sulphide) resided.

A sample gave when divided into these various sizes—

Above 12 meshes per inch.	=	0·25 sulphur.
12 to 16	,,	0·17 ,,
16 to 24	,,	0·16 ,,
24 to 30	,,	0·17 ,,
30 to 40	,,	0·18 ,,
40 to 50	,,	0·19 ,,
Under 50	,,	0·17 ,,

Some continental refiners use caustic soda to remove organic matter from their char previous to burning.

Expt. 3.—1 lb. stock char was boiled with distilled water containing ½ per cent. sodium hydrate upon the char taken. After perfect washing and drying the sulphur was estimated.

Total sulphur stated as calcic sulphate—

Char before treatment.. ..	1·125 per cent.
Char after treatment	0·915 ,,
Sulphate lost..	0·210

But the sulphate as such amounted to—

Before treatment	0·26 per cent.
After treatment	0·27 ,,

Consequently the soda attacked the sulphides in preference to the sulphates. A foreign refinery char, in which soda was used, yielded—

Calcic sulphate	1·520
Sulphur..	0·012

Ferrous sulphide is quite readily decomposed by alkalies, and all the evil effects known to arise from the presence of an excess of sulphide in char can be much more easily explained by assuming its presence in preference to calcium sulphide. A curious deposit is frequently seen on the inside of the kiln pipes in certain houses,

in fact, more or less in all, but when in great abundance is an evidence of excessive heating. The following results express its composition :—

	I.		II.
Iron	60·92	..	57·55
Sulphur	35·77	..	31·37
Carbon	—	..	3·10
Sand	0·41	..	3·30
Tricalcic phosphate and loss	2·90	..	5·36
	100·00		100·68

Sp. gr. 4·12

The iron and sulphur calculated to per cents are as follows—

		Theory.		Pipe Deposit. I.		II.
Iron	56	63·64	..	63	..	64·73
Sulphur ..	32	36·36	..	37	..	35·27
	88	100·00		100		100·00

It is worthy of note that it is extremely rare to find an accidentally formed iron sulphide having so near an approach to the theoretical numbers. There is generally excess either of iron or sulphur. This deposit is not formed at the expense of the iron of the pipes. These remain *apparently* unchanged. The sulphur and iron have both been undoubtedly derived from the char itself. I propose shortly to show the changes which take place in iron heated constantly in contact with phosphates, and discuss the alleged occurrence of phosphides in char. My thanks are due to my assistant, Mr. John Macdonald, for his help with certain of these and also some succeeding analyses.

Greenock, Sept. 28, 1874.

(*To be continued.*)

Sugar Refining in Melbourne.—We understand that the new firm of Barr & Co., Cartsburn Copper Works, have contracted with Messrs. Joshua Brothers, of London and Melbourne, for an additional large vacuum pan for their sugar refinery, in the latter city at the antipodes. The young and enterprising firm of J. & R. Houston, Cartsburn Foundry, have also contracted with Messrs. Joshua for additional char-kilns, &c., for the same establishment.

THE DUKE DECAZES ON TREATY OBLIGATIONS.

To the Editor of "The Standard" (London).

Sir,—Your Paris Correspondent's telegram of Oct. 26, contains the following quotation from a speech made by the Duke Decazes at Bordeaux:—

"That is the key to our foreign policy. It rests on the strict and scrupulous fulfilment of the treaties which bind us to other Powers. . . . I claim their strict observance, and tender on my side their loyal fulfilment."

I wish, sir, to call your attention to the contrast which this statement offers to what has actually taken place, as narrated in a parliamentary return just issued, entitled "Correspondence relative to the Sugar Convention of 1864." In a note addressed by Lord Lyons to the Duke Decazes, dated Feb. 13, 1874, occurs the following passage:—

"Her Majesty's government are willing to consider any definite proposals for the amendment of the Convention of 1864; but they think that it is of great importance that, so long as that Convention remains in force and unaltered, it shall be faithfully observed by all the Four Powers concerned in it; and accordingly they trust that, should no fresh agreement be arrived at within a short period, the French tariff will be adapted to it without delay."

In a letter from the Treasury to the Foreign Office, dated March 30, 1874, it is directed that "The British representative should urge the impossibility of submitting to the present evasion of the treaty."

On March 31, 1874, Lord Lyons reports, that in conversation with the Duke Decazes, "I replied that I must remind him that during all the time he was employed in these preliminary measures France remained open to the imputation of avoiding the punctual execution of the Convention of 1864."

In a report addressed to the Lords of the Treasury by the Commissioners of Customs, dated March 26, 1874, they conclude by saying:—

"It will be necessary, therefore, to watch the course of French legislation in this respect, but immediate action is not imperatively called for, more especially as the French government have already been so strongly urged to carry out the stipulations of the Convention."

But on July 2, 1874, Mr. Kennedy writes from Paris to the Earl of Derby:—

"It seems improbable that the Convention of 1864 will be completely executed by France."

Mr. Smith, writing from the Treasury to Lord Tenterden, on July 31, 1874, says:—

"Adverting to the observations which my lords have felt it incumbent upon them to make, they must now remark that England has steadily exerted herself to obtain a faithful execution of the provisions of the Convention of 1864, but that, for reasons which her Majesty's government have always found it difficult to understand, France has failed to give effect to it."

Lord Derby, on August 20th, writes to Lord Lyons:—

"It is a matter of regret to her Majesty's government that nothing has yet been done to carry into full effect the Convention of 1864."

Finally, on August 28, 1874, only two months ago, Lord Lyons writes to Lord Derby:—

"I spoke yesterday to the Duke Decazes in the sense of your Lordship's dispatch of the 20th instant, respecting the sugar question. I reminded the duke that, after having herself proposed to Great Britain, Belgium, and Holland, a mutual agreement to abolish bounties on the exportation of sugar, after having entered in 1864 into a formal Convention with those Powers binding herself to do so; and after having seen the stipulations of that Convention punctually and scrupulously executed by Great Britain, France had now for nine years evaded the execution of them herself, and had recently, by increasing the sugar duties, increased proportionally the excess of the drawback given above the duty actually paid, and had thus, in fact, augmented the bounty on exportation. During all this time Great Britain had, I said, steadily exerted

herself to obtain from France a faithful execution of the Convention of 1864; and I added that I was now instructed to make an urgent representation to him on the present state of the question."

The contrast which I have attempted to draw between the professions of the Duke Decazes as reported in your columns yesterday, and his failure to carry them out, as shown in the extracts from the official correspondence which I have quoted, appears clear enough to require no comment. We can only hope that the Duke's desire to promote free-trade principles will enable him to overcome the passive resistance which the French governmental Department of Commerce has till now offered to all attempts to procure from France an execution of commercial treaty engagements.

I am, Sir,

Your obedient Servant,

London, Oct. 28. M.

New Process for Sugar Manufacture.—Auteuil de Savignon proposes to break the cortical membrane of the sugar cane by mechanical means, and then to dry the canes cut into suitably-sized portions or discs. When required to extract the sugar these discs are treated with cold water, whereby a pure solution of sugar is immediately obtained of sp. gr. 15° B, and containing very little glucose. The operations of refining are thus much shortened, whilst the fermentation taking place in the cut canes is obviated. —*Bull. Soc. Chim., Paris*, xx. 12, 235.

Beet-root and Chemical Manures.—1000 kilos. of nitrate of soda, supposed to be pure, contain 364·7 kilos. of soda, representing 835·28 kilos. of sulphate of soda. Hence, 1000 kilos. of nitrate of soda introduces into the soil materials capable of converting 3758·75 kilos. of sugar into molasses, a fact which explains the unsatisfactory results obtained by sugar manufacturers when this salt has been used. The sulphate of ammonia has not this injurious property.—*From Les Mondes, Revue Hebdomadaire des Science, Nov. 12, 1874.*

MR. RUSSELL'S PATENT FOR IMPROVEMENT IN EXTRACTING CANE JUICE.

In our summary for the last packet we stated that within a very short time a process, by which 14 or 16 per cent. of sugar in our canes, would be in operation in the colony. All mystery in the matter has been dispelled. In the *Official Gazette* of Saturday evening last there appeared a notification that the Hon. William Russell had obtained provisional protection for twelve months for "A mechanical process for extracting additional cane juice, by means of maceration and second crushing," and it has already been established by practical experiment that his invention more than realises the results predicted.

We have been favoured with the following particulars of one of the many trials made on a large scale of Mr. Russell's process, which puts the question of power required and fuel necessary to evaporate the water employed in maceration in a clear and concise form. The "Windsor Forest" engine is of 60 horse-power, working a powerful mill, 72 inches by 34 inches, considered one of the finest in the colony. The canes experimented upon were analysed on a small scale, and were found to contain :—

Sugar	16·11
Megass	15·77
Water	68·12

A punt load of these canes, weighing 7,813 lbs. avoirdupois, was passed through the mill in nine minutes, and gave 484½ gallons cane juice, marking 9·5° by Beaumé's saccharometer, or 10·71 lbs. per gallon, and polarised 103°, or a saccharine richness of 1·68 lb. per gallon. This would indicate $484{\cdot}5 \times 10{\cdot}71 = 5{,}188{\cdot}995$ lbs of cane juice; and of 7,813 : 5,188·995 :: 100 : 66·41 per cent. as the crushing power of the mill, and $484{\cdot}5 \times 1{\cdot}68 = 813{\cdot}96 \div 7813 = 10{\cdot}41$ as the per centage of sugar expressed from the cane as due to first crushing.

The megass was macerated with 200 gallons of water, and passed through the mill in eight minutes, the result being 207 gallons, marking 6° Beaumé, or 10·13 lbs. per gallon, and polar-

ised 70°, or 1·14 lbs. of sugar per gallon; therefore, 207 × 10·43 = 2159·01—2000 (water added) = 159·01 lbs. of cane juice, due to second crushing, or 2·03 per cent. of the original canes, making the crushing 66·41 + 2·03 = 68·43 per cent.; but the washings, 207 × 1·14 = 235·98, or 3·02 per cent. of sugar, on the original weight of canes, together, 10·41 × 3·02 = 13·43 per cent of sugar out of 16·11, shewing 2·68 per cent. of sugar still remaining in the cane, but which may be all taken out by a slight addition of water and steam to the megass in passing from one mill to the other, all of which is fully provided for in Mr. Russell's finished arrangements.

The megass was then carefully gathered and weighed and found to be 2024lbs. This from the original canes, 7813lbs., leaves 5789lbs. extracted, or 74·09 per cent. It will be seen that this does not agree by 441lbs. with the juice actually received into the clarifiers; but this loss is accounted for by the great evaporation which takes place during the different handlings. The megass was next spread on a brick pavement and made thoroughly dry, when it was again weighed and found to be 1340lbs., having lost 684lbs. in drying. It was then used as fuel, and served to supply a couple of copper wall furnaces, each 5 feet by 3 feet wide, or 30 square feet of fire grate, for 16 minutes, or nearly as long as the mill was employed in the double operation of crushing, clearly indicating that the megass was not injured as fuel.

It will thus be seen that so far the experiments must be considered as most successful; but we know that gold can be purchased at too high a price, or, in other words, the game may not be worth the candle.

We have seen that by polariscope indications, the punt load of canes dealt with in the ordinary way would give 814lbs. of sugar; and four of such punts ($484\frac{1}{2} \times 4 = 1938$ gallons) would give a hhd. of sugar, weighing 1900lbs. avoirdupois, and 50 gallons of rum, requiring sweets equal to 17lbs. per gallon, or 850lbs, together 2750lbs. reduced to sugar. Against this $814 \times 4 = 3256$, showing a loss in manufacture of 506lbs. on the polariscope reading; or, if 3256 loses 506, what will 100? 15 per cent. loss; or in round numbers, we have in sugar 60 per cent., rum 25 per cent., loss

15 per cent. Treating the juice of maceration in the same way, we have :—

207 × 1-14 = 236 lbs. indicated per punt × 4
= 144 lbs. indicated ; and

944 at 60 per cent.=568 lbs.
944 at 25 ,, ...236 ÷ 17=14 gals. rum
944 at 15 ,, ...141 loss.
568 less 10 per cent. at 512 at 5:80 = 29 69 dollars.
14 gallons rum at 60c..... 8 40 ,,

dollars 38 09

per hhd. gained by maceration. Against this we have the cost of extra appliances as under for, say, an estate making 2000 hhds. of sugar :—

	dollars.
3 High Pressure Boilers, 60 h.p. each in position would cost	11,000
50 h.p. Engine Mill and Macerator	30,000
4 of Russell's Water Traps	480
1 5-Ton Vacuum Pan, complete with Engine, &c., &c., ...	10,000
4 Improved Clarifiers	1,800
1 Centrifugal	530
dollars	53,810

Working Expenses.

Interest on above sum at 20 per cent. for wear and tear	10,762
1,000 hhds. Coal for Grinding at 6 dollars	6,000
Evaporation of 2,000 × 800 galls. 1,600,000 × 10 ÷ 2,240 ÷ 6 = 1,200 Tons Coal at 8 dollars	9,600
Firemen and Contingencies	2,000
dollars	28,362
2,000 hhds. with offal as above, representing 38:09 dollars per hhd.	76,180
Apparent profit, dollars	47,818

It is not the first time that the use of scientific instruments has been the means of revealing unsuspected riches, and enabling the manufacturer and chemist to turn the raw material passing through their hands to very much greater advantage than ever before; and we doubt if Mr. Russell would have ever found out a practical way of extracting this extra quantity of sugar out of the sugar cane had it not been for the aid derived by him from the use of that wonderfully delicate and accurate instrument the polariscope. Others have laboured in the same field, and have made valuable discoveries, but we question if any of them were possessed of the varied abilities and command of means and opportunities which Mr. Russell has brought to bear on the whole subject; and we congratulate our planter friends on the fact that Mr. Risien, the eminent practical engineer who has worked with Mr. Russell, in this and other important improvements in machinery, for the manufacture of our staple product, goes to England by the next mail to superintend the making of the necessary machinery, so that we may hope to see, within a few months, Mr. Russell's new process in operation, and giving even larger profits than are foreshadowed in the foregoing remarks.

There is one way of looking at the question which seems to leave no room for doubt, and that is the fact that juice richer than the beet sugar manufacturer has to deal with is at once gained by the process; in other words, our planters will have 50 per cent. of juice added to their product, richer in saccharine and much easier to deal with than the crude juice of the beet. Mr. Russell expects that the reduced cane juice will be susceptible of a much finer clarification, and that the juice will be purified and ready to boil in vacuo at a much lower gravity than the juice obtained by the appliances at present in use. It is well known that the beet sugar boilers have to keep their juice at or below 5° Beaumé, otherwise their defecation is faulty; and we can readily understand that the same will hold good with cane juice; in fact, we have often seen buckets of clean water thrown into the tayches when the syrup had arrived at 20° Beaumé to facilitate the separation of impurities. We understand that this is often done with rich juice in Barbados.

PROTECTION TO BIRDS AND TREES.

From the multitude of abundance, springs the wantonness of waste, although it very often happens that that which appears to be a superfluity is nothing of the kind. But in nothing more strongly is such a sequence exemplified in these colonies than in the way we deal with our timber and our birds. We cut down trees at random, and do nothing to supply the future want which will inevitably come upon us, and we are gradually exterminating every feathered tribe in the vicinity of our larger towns. Every holiday, nearly every Sunday, and on most fine evenings, the dwellers nigh Brisbane may hear the indiscriminate raid of hobbledehoys and men who advance in years without growing in wisdom, upon all the birds who come within gunshot, whether edible or not. It may seem fine sport to the zanies who indulge in it, but it is in reality, not only cruel in itself, but mischievous to the public, more especially to those who are engaged in agricultural or horticultural pursuits. This colony literally swarms with insect life, and a considerable portion of that is by no means favourable to the growth of either fruit trees or vegetables or cereals of any kind. Here the services of birds are most valuable; most of them have their special food, and many of them find it in those insects which do the greatest damage to the garden and the field. It has not escaped the notice of observant cultivators that there has been of late years a very great diminution in the number of birds within a few miles of Brisbane, and a corresponding increase in the quantity and ravages of insect pests. It may be very enjoyable fun to those who carry a fowling-piece for mere wantonness of sport to roam at their own sweet will, and kill, if they can, all that they dare to shoot at. But their mirth brings no echo from the farmer whose crops bear the consequence? and it is a great pity that they cannot be made responsible for the damage that follows upon their selfish and childish folly.

At this time of the year such indulgence is doubly culpable and doubly mischievous. The birds are beginning to lay, and every one killed may represent a tenfold ultimate loss. From the want

of restriction upon the silly pastime at this season of the year, we are threatened with the gradual extermination of many valuable species, useful for food as well as in their work of checks to the insect tribe. In New South Wales they have a close season, in which it is not lawful to kill any wild or forest bird. We shall not be suspected of any wish to see the introduction on this side of the world of those oppressive enactments which we knew in England as the game laws; but there is a very great difference between protecting game in the interest of an individual and protecting it in the interest of the public at large. There is as much reason to prevent its being interfered with during the period of incubation and early growth, as there is to protect oyster-beds at an analogous time—if not more. For, if we lose the oyster, we lose one article of food; by killing our birds we not only lessen the variety available for the table, but indirectly inflict injury upon the agricultural producer, and ultimately upon all who depend upon his labours. It is difficult to an unthinking or ignorant person to realise the important part played by many of our birds in the economy of nature. We are only just beginning to perceive it here: in the old world they have been taught that perception by more than one severe lesson. In one of the southern departments of France the residents, peasants, and proprietors became a few years back possessed with the idea that the birds were mischievous to their vines, and a war of extermination was waged against them—the sparrow especially—with such success that scarcely any were left in the district. If we can imagine caterpillars to rejoice, there must have been great rejoicing amongst them at this inconsiderate step; at any rate, they grew and multiplied to such an extent that vegetation became almost as rare as birds; and the last we heard from that district was that the leading proprietors and landowners were importing birds, sparrows and all, with as much speed as possible, in the hope of benefitting by services which in past time they were too ignorant or too prejudiced to recognize. We may take a lesson from their experience.

In reality we are too careless and too wasteful in dealing with

our forests and their inhabitants. There is very little good timber left in any accessible spot within some miles from Brisbane; for we forget that a tree is not grown in a man's lifetime, and we take no thought to provide for the replacement of that which is consumed. In Victoria the conservation of forest reserves is receiving great attention, simply because experience has shown the necessity of such measures; and with us that necessity will soon be equally felt. There is a distance beyond which the carriage of timber becomes practically impossible because of its cost. If within that circle you destroy every tree that is useful, and do nothing to replace them, what is it but in effect either heightening the price to a prohibitory extent, or rendering the importation of the wrought material profitable. By the ruinous process now going on, the timber getters, and all who depend upon them, are just cutting their own throats, as they will find to their great discontent before many years are past. It would be wise, then, for the State to fix reserves within which no trees should be felled—to place some restrictions as to the size and age of trees allowed to be cut down on the Crown lands outside the reserves, and thus to secure a provision for the future, and a succession of growths that would tend to a continuous supply. No one could rightfully be discontented, because the interests of all would be promoted.

And in like manner it is fast becoming necessary that the killing of our native birds should be prohibited during the breeding season, for if this were done, not only would the supply of edible game be multiplied when it was most healthy for food, but the farmer would be helped in the contest with his insect enemies precisely at the time when they are most noxious — the spring of the year and the early summer, when the bud is yet tender, the blade young, and the fruit most exposed to attack. No one could complain but the thoughtless juveniles who, provided they may shoot, are not particular at what or under what circumstances. If they must have delectation, let them have posts and whirligigs on which to try their dexterity; but it is rather too much that we should be compelled because of their inconsiderate amusement to contemplate the possibility of within

the next score or two of years, finding our acquaintance with some of the finest ornithological specimens in the colony confined to what may be gathered from the pages of Kreft or Gould. Only very great thoughtlessness could render such a contingency even remotely prospective, and only an equally culpable remissness on the part of those with whom the power rests will permit the further indulgence of such folly. The Legislature has exerted itself to protect the oyster; let us hope to see it awake to the, at least, equal importance of our forests and birds.—*The Queenslander*.

NOTE ON THE ANALYSIS OF SUGAR.

By J. M. Milne, Ph.D.

The determination of the fruit sugar in samples of raw sugars is a matter of no difficulty in the hands of a careful manipulator, but there are a few points in detail which are deserving of attention. The usual plan, still in use in some laboratories, of taking a weighed quantity of the sample, dissolving in water, and making up to a given bulk, and using the liquid so obtained for the determination of the fruit sugar, is by no means always to be relied on. There is no doubt, I think, that many dark-coloured sugars contain other substances (probably albuminous) besides the fruit sugar capable of reducing copper solution, and which must first be separated before correct results can be obtained. The method recommended by Fresenius, of adding lead acetate to the sugar solution till no further precipitate is formed, may be advantageously employed for this purpose. While in some samples the same amount of fruit sugar is found in the solution *before* precipitation with lead as that obtained *after* the addition of that reagent, in others the difference is very marked. The following results, obtained from a sample recently submitted to me for analysis, will illustrate this:—The sugar solution *without* treatment gave 4·90 per cent of fruit sugar, while in a measured quantity of the same solution *after* precipitation by lead acetate the amount found was 3·27 per cent.

The following method of procedure answers very well, and is

employed by me for *all* sugar samples in which fruit sugar is to be determined:—5 grms. of the sample are dissolved in a moderate quantity of water, and the insoluble matter allowed to subside. The supernatant liquid is then carefully poured into a 100-c.c. flask, the insoluble treated with more hot water, and finally collected on a small weighed filter, and the washing continued till the flask is about three-quarters full. To the sugar solution a little solution of tribasic acetate of lead is added, the whole well shaken, and the precipitate allowed to subside. The clear liquid is then tested with a drop or two of acetate, and, if no further precipitate is produced, the contents of the flask are cooled to the proper temperature, and finally made up to the mark with water, the whole being thoroughly mixed. When the precipitate has subsided, the liquid is passed through a *dry* filter into a clean dry glass, and when sufficient has passed through, is ready for the fruit sugar determination. If it is desired to determine the extractive matters *directly*, the precipitate in the flask is washed several times by decantation, and then placed on the filter (previously weighed), and the washing continued till a drop of the filtrate no longer gives a precipitate with H_2S; the filter and contents are then dried as usual. By the above method of treatment, a clear colourless solution is always obtained, which renders the further operations with the copper liquor much easier.

Chemical Laboratory,
144, *West Regent Street, Glasgow.*

CANE CULTIVATION.

Sir,—Your Correspondent "N" says, "with manure enough, applied in time, for the soil to digest it into the state that plants can assimilate it into their systems, we can now grow canes, that will weigh 50 lbs. to a hole or bunch, and twice that under very favorable circumstances. Now the average weight of a foot of cane is $\frac{3}{4}$ of a lb.; 12 feet would be 9 lbs., and 12 canes or a hole 12 feet long, would give us 108 lbs., equal to 8 gallons of juice under

a pressure that gives 64 per cent. Every gallon will average one pound of sugar ; of course canes at only half the length would only give us half the quantity of sugar; but only at 50 lbs. to the hole, and 4 lbs. of sugar, our lining of 6 by 5 feet would give us 6000 lbs., nearly 3 tons to the acre." If this statement is correct, it follows that the annual crop of sugar is capable of a considerable increase, dependent upon proper application of a sufficient quantity of manure. The subject is of so much importance to the agricultural interest, that I am induced to examine the statement more in detail. What does "N" mean by "a foot of cane." I take him to mean as many joints of cane as measure a foot, 3, 4, or 5 joints according to their length, and without regard to the thickness. He speaks of a foot in length of the ordinary thickness of plant canes, say of a diameter of 1½ inches, containing an ordinary amount of saccharine matter, in other words, with juice of ordinary density. A foot of cane of this kind says "N" would weigh ¾ of a pound, and so a cane 12 feet long would weigh 9 lbs., and 12 canes of the same length, or 144 feet of cane would weigh 108 lbs., and yield 8 gallons of juice at a certain pressure, which is equivalent to 8 lbs. of sugar, at the ordinary rate of a gallon of cane juice to 1 lb. of sugar.

The canes are planted in squares of 6 by 5 feet ; one plant in each square or hole of 30 square feet ; and "N" takes an average bunch of 12 canes to grow in every hole in the field, each cane 12 feet long, and the bunch weighing altogether 108 lbs. But this growth, he admits, could only take place "under very favourable circumstances." One may often find canes 12 feet long, but that is not the average length of the cane ; nor are so many as 12 found in a hole or bunch on the average, although here and there in the field one may meet with bunches of more than 12, sometimes over 20 canes, from the same stool. "N" therefore takes an average growth of half as much cane to the hole, say 6 canes 12 feet long each, or 12 canes 6 feet each, which would give 54 lbs. of cane to the hole, equal to 4 lbs. of sugar. An acre contains 1452 holes of this lining, and would yield 5808 lbs. of sugar, at 4 lbs. to each hole ; or 2 tons, 11 cwt, and 96 lbs. over 2½ tons to the acre. This

calculation is reasonable enough. It is clearly within the reach of what might be expected of an acre of land in good heart, highly manured, with favourable weather, and reaped to advantage. Yet it is far beyond,—about double the actual yield of the sugar crop of Barbados, which is generally estimated at 1¼ hhd. to the acre.

It shows what we may expect to accomplish by improvements in the mode of cultivation, and what room there is for it. This is "N's" object, and I need not say how praiseworthy it is, and how deserving of the attention of the planters and proprietary body. It is not a little extraordinary that high as the cultivation of the land is in Barbados, and great as the average yield per acre in comparison with our neighbours, it is is quite possible to almost double the sugar crop, without increasing the breadth under canes. "N" proposes to increase the sugar crop, at the same time that he would reduce the quantity of land under canes by nearly a third in order to introduce the rotation system, and the planting of fodder for keep of a large number of cattle on the estates, with less expense for foreign manures. If this can be done I know of no greater benefit that can be conferred on the planting interest, than to show how to do it.

Yours,

A PLANTER.

"West Indian," Barbadoes, September 15, 1874.

TRINIDAD.

The following Memorial, from the Trinidad Planters' Association, has been forwarded to His Excellency the Administrator for transmission to Her Majesty's Secretary of State for the Colonies. :—

To the Right Honorable the Earl of Carnarvon, Her Majesty's Principal Secretary of State for the Colonies.

The Memorial of the Trinidad Planters' Association

Respectfully showeth.

That this colony in common with all the other British West India Colonies, is suffering greatly from the unfair advantage en-

joyed by the Refiners of Sugar in France, who are enabled to introduce their refined sugar into Great Britain at lower rates than it can be manufactured by British Refiners, causing thereby a diminished demand from the latter for West India sugars.

That the consumption of West India sugars has lessened in consequence, and the very low price that has ruled for the raw article for the past three years, is attributable in a great measure to this cause.

That undue advantage is given to the French Refiners who obtain a drawback on the export of their sugars in excess of the equivalent of duty actually paid upon the raw material, and the bounty thus obtained by them from the French Government enables them to compete unfairly with the British Refiners, and indirectly inflicts great injury upon the West India Colonies.

That your Memorialists remark that the Assembly in France being fully alive to the great loss to the national revenue in consequence of the unfair protection given to their Refiners, have lately decreed that from July, 1875, refining in bond shall be adopted and all bounties abolished.

That the French Legislature, although admitting the injustice of the present state of the law in France, has nevertheless postponed the removal of the evil complained of, and in the meantime the interests of the British West India colonies continue to suffer.

That your Memorialists respectfully pray that Her Majesty's Government will take such steps as will result in the immediate abolition of the bounty now so unfairly enjoyed by the French Refiners.

And your Memorialists will ever pray.

We are glad to find our views respecting the Cane Sugar Question confirmed by the authority of the *West India in London.* It is true that the French Government has promised that towards the end of the coming year Refining in Bond will be substituted in France for the export drawback on Refines now existing, and through which the bounty to refiners is kept up ; but the very fact

ought to induce the manufacturers of Cane Sugar to make arrangements at once to overwhelm their insolent enemy as soon as the latter will have been deprived of the unnatural advantages which conferred on it so much favourable odds. Should even the partial abolition of the French export duty on Beet take place, and science be called in to the aid of the Cane Sugar, there is no doubt that the latter will outstrip the former completely. The *West India in London* however remarks, that simply admission of the greater saccharine richness of the Cane as compared with Beet-root, unaccompanied by practical action to develop that superiority, will be of no avail. Every exertion must be used to obtain a greater quantity of juice from the Cane, and a better class of Sugar from the juice. To effect this, however, must be the work of the numerous absentee proprietors and mortgagees in England, who hold our destinies in their hands. So far as the Jamaica planter is concerned, his views (notwithstanding what so many assumed censors who know absolutely nothing of the condition of the sugar industry of this country, venture to imagine to the contrary), are of the most enlarged and intelligent character on these subjects; but he is not free to act. He is not master, nor would he possess the necessary capital if he were master, to do what his good sense suggests. We would be glad to find our absentee proprietors and mortgagees joining the Colonial League suggested by the *West Indian in London*, to set on foot the necessary scientific inquiries, and to give effect to the knowledge which will be acquired through them. It is but a truism to say that "an additional twenty per cent. of juice from the Cane would have a great influence upon the fortunes of the Colonies." And we quite agree in the belief that the present despondency and gloom would soon, under the influence of practically improved prospects, give place to the cheerfulness that comes of prosperity, that fresh vigour would be infused into the industry, capital be induced to flow, all classes be benefitted, and Colonial institutions strengthened.—*Jamaica Standard, Sept.* 24, 1874.

PRODUCTION OF UNCRYSTALLISABLE SUGAR DURING SUGAR REFINING.

F. Anthon has made various experiments as to the alleged power possessed by certain substances in preventing the crystallisation of sugar. Some consider the cause of molasses to be solely organic matters of a gummy nature, or extractive and colouring matters; others attribute the formation of uncrystallisable sugar to the presence of certain salts; whilst others class all bodies (organic and inorganic indifferently) into three categories, viz., those which prevent the production of molasses; those which favour its formation; and those which are wholly indifferent.

Chloride of sodium, in small quantity, diminishes the solubility of sugar, and causes it to crystallise out from a cold saturated solution; but a large quantity of that salt prevents the crystallisation from taking place at all. For instance, crystals of sugar separate on cooling, or on standing, from the following liquid, prepared hot:—

Sugar	100 to 110 parts.
Dry chloride of calcium	8 ,, 12 ,,
Water	50 ,,

On the other hand, with the following proportions:—

Sugar	50 parts.
Chloride of calcium	85 ,,
Water	100 ,,

The chloride of calcium separates out in crystals as the mass stands, and the sugar remains dissolved, without losing its power of crystallising however.

Yet again, with the following proportions:—

Sugar	110 parts.
Choride of calcium	30 to 40 ,,
Water	50 ,,

A molasses-like liquor, depositing no crystals of any kind, results. Hence chloride of calcium (and other substances) may act in either of three ways—facilitating crystallisation, producing molasses-like sugary substances, or indifferently.

On the whole, any substance which renders the syrup more thick and viscous, prevents crystallisation. The author considers that the sugar in molasses is for the most part free, and not combined with any of the accompanying substances.—*Bull. Soc. Chim.* xxii. 233; *from Dingler's Polytech. Journal*, ccxii. 414.

Sebor's Method of Preparing Sugar from Molasses.—O. Peller states that, in a trial experiment, 250 cwts. of molasses, containing 45 per cent. of sugar, were worked up to 450 cwt. of sugar-lime. The diffusion-water carried away with it 3 per cent. of sugar. The result of the whole operation stands therefore thus :—

250 cwt. of molasses, containing 45 per cent. of sugar	112·5 cwt. sugar.	
Loss in 1·700 cwt. of diffusion-water, at 3 per cent.	51·0	,,
Yield	61·5	,,

which corresponds to 24·48 per cent. of sugar, a highly satisfactory result.—*Dingler's Polytech. Journal*, ccvii. 410.

VIOLENT STORMS IN CUBA.

Havana,

Monday, November 16th, 1874.

Violent storms have prevailed in the eastern part of Cuba. Several towns were flooded, and some people have perished. Much of the sugar cane crop has been blown down.

THE COOLIE TRADE.

From January 1, 1872, to the end of February in the present year, 59 voyages were made from India, and 27,086 coolies sailed from their native country to our western possessions. 176 births took place among these humble passengers, and 1,162 died before reaching their destination. Of the Indians who embarked, by far the largest number were bound for British Guinea; 7,290 proceeded to Trinidad; while only 3,910 were destined for Jamaica. A single cargo of labouring emigrants left China, and consisted of 388 individuals, who went to Guinea.—*Barbadoes Globe, Oct. 22, 1874.*

Correspondence.

ACTION OF MANURES ON BEET AND CANE.

To the Editor of "The Sugar Cane."

Sir,

I have read with considerable interest your able report of the lecture delivered by Mr. Georges Ville at the Belgian *Société Centrale d' Agriculture*, in which he proposes to be able, by means of a *judicious choice of seed*, and *liberal application of manures*, to raise the yield of sugar from the beet root to the very creditable figure of 14 *per cent.* I need scarcely inform your readers that this has never before been done and that, relying upon his statements, we may shortly expect a complete revolution in beetroot culture, if cultivators follow out the two conditions above referred to. But he also extends his remarks to the cane, promising like results, and this concerns us more.

With regard to the cane he says nothing about a judicious choice of seed (or plants) but relies entirely on Manure to increase the yield of sugar almost *ad infinitum* on a limited surface. I desire to call attention here simply to the *money value per acre* which, he informs us must be put upon the soil to produce these results. Taking his own figures, 400 francs, or £16 to the hectare (cost of the manure *independently of carriage* to the colonies) this is about £6 8s. 0d. *per acre* that the materials cost, putting aside cost of transport. Now, I believe that if we add another £1 for carriage to the colonies and incidental expenses, we shall be rather under the mark; therefore in round figures £7 7s. 0d. *per acre* may be taken to represent nearly the amount we are told to put on our soil to obtain these desirable results. I fear this will prove rather too much for the nerves of our good friends in the West Indies who expect to get a tolerable increase on expending £2 2s. 0d. per acre on manure, and who have got in numerous instances a very large increase of sugar with an outlay of £4 4s. 0d. per acre expended on properly chosen manure.

I am rather surprised that none of the Belgian Professors present requested Mr. Ville to show them how to do things more economically; judging from the experience gained by a long residence in their country I doubt that any Belgian cultivator will risk half the money on a crop of beet, whatever the French may do in their colonies.

But I would also allude to a passage in Mr. Georges Ville's lecture which serves as an excellent criterion by which we may judge whether or no he "dreads exaggerations"; and form some conclusion as to the value of his remarks in general upon these most important subjects. When I had formerly the pleasure of a short acquaintance with that gentleman in Paris he was completing his education as an agricultural chemist, and referring at the present day to the most difficult branch of that science, chemical analysis, he exclaims (p. 650) that making 6 or 7000 analyses of beet "is but play"—that children of 10 or 12 years of age "are capable of doing this work with unimaginable rapidity"! For my own

part I should much like to feel assured that Mr. Ville himself can determine accurately the quantity of sugar in a sample of beet, for with this assurance I should be able to rely on his figures, and to gain some idea of the increased yield produced by the manure.

I am Sir,

Your obedient servant,

T. L. PHIPSON, Ph.D., F.C.S.,

Formerly of Brussels University.

The Cedars, Putney, London, S.W.,
10th November, 1874.

Birmingham, October 27th, 1874.

To the Editor of "The Sugar Cane."

Sir,

The following tables will be useful for the purpose of comparison with the statement of the Shipments of Sugar from the British West Indies given in your last.

1.—Exports of Sugar from British Colonies.

2.—Exports of Cane Sugar from foreign sugar producing countries per Rueb and Ladeboer's report.

3.—As, in Australia, sugar is mostly grown for home use, the following area under cane cultivation is given to show the rapid increase in the production of that country.

C. D. Sturge.

Exports of Sugar from British Colonies

(in tons.)

	1870	1871	1872
West Indies	226,204	265,118	220,474
Mauritius*	101,080	122,408	126,058
Natal	5,329	8,741	7,097
India	19,282	17,265	20,964
Penang (No return published)			

*At 110 per quintal.

Exports of Sugar from Foreign Producing Countries

(in tons.)

Per Rueb and Ledeboer's Report.

	1870	1871	1872
Cuba	725,505	547,441	711,795
Porto Rico	102,110	103,304	89,559
Brazil	101,509	143,975	157,809
Guadaloupe	34,211	38,434	31,786
Martinique	38,252	41,821	39,699
Surinam	11,154	11,854	12,291
Java	120,783	201,928	207,842
Manilla	78,220	87,400	91,701
Réunion	42,655	23,533	33,100
Egypt	12,630	15,863	20,359
Louisiana	72,441	64,231	69,800
Peru	No	return	given.
Central America	,,	,,	,,

Area under Cane Cultivation in Australia.

New South Wales.		Queensland.	
	Acres.		Acres.
1866-7	117	1865	420
1867-8	647	1866	608
1868-9	2584	1867	1995
1869-70	3918	1868	3397
1870-1	4082	1869	5165
1871-2	4393	1870	6341
1872-3	5471	1871	9581
		1872	11757

OUGHT WE, OR OUGHT WE NOT TO REMOVE DRY CANE LEAVES FROM THE CANE?

My attention has been frequently drawn to articles in *The Sugar Cane* in favour of or against trashing the canes. It is a common phrase among planters, but when I was one, it meant with us, stripping the dry leaves from the canes so as to give them air and ventilation, and assist in ripening them a week or two before they were to be cut.

The very fact of the necessity for such an operation implies close planting in the first instance, or not having weeded and cleaned the cane during the early growth. In saying close planting I do not specify canes planted at so many feet square, distance between each plant, as being close or apart; the same distance between plant and plant may be close planting for some lands, and wide planting for others. For instance:—Some years past I put in a stretch of one hundred and thirty acres, at five and a half feet distance from bank to bank, by five feet from plant to plant in the furrow, and I had reason after to regret having planted too close; at the same time I planted eighty acres in another part of the estate, at five and a half by four, and had not the same cause to think I had committed an error.

Most planters like to see their sprouts come out plentiful and close. I do not! I was once invited by a planter to go and see a field of his canes, and assured it was something beautiful. It was in a Spanish county. I quite horrified him by saying that were they mine I should dig out half of them. I was afterwards manager of his estate. This happened many years ago, and to the present day there exists a mutual friendship between us. Of course each planter thinks his own mode of working is the best. I do!

In mentioning canes, I suppose we treat of a field of canes worth cultivating—plants that, at worst, would give two tons of sugar an acre. Let me ask a simple question. Are not canes very brittle, more especially when they are lodged? And if a field of canes, such as I speak of, is so choked with trash as to require

being stripped, would it not be an almost certain consequence that these canes would be what planters call lodged? The only place in the world where I have seen canes luxuriant, ripe, and not lodged, was in the Carbib County in St. Vincent; it was a peculiarity which attracted the attention of all planters who visited that locality. I speak of things gone by a quarter of a century since. May be it is so still!

But planters must infer that canes on the eve of being cut, but being at the same time overloaded with trash, must be lodged. Now the query is:—Which will be the greatest injury? A gang of people treading through these canes, as they must do, to strip and lay the trash, so that the air may penetrate and ripen them, or the trash still left on them.

Before any planter attempts to reply, let him make a bee-line on foot, and with the greatest care, straight through his finest and ripest field of canes. Let him count the number of times he hears a cane crack, as it breaks under *his careful* treading, calculate that each cane which cracks will in a fortnight be rotten and unfit for sugar making. After he reaches the other side of the piece let him multiply the cracks heard or felt by the number of rows of canes in the field; put one hundred per cent. *at least* for careless *versus* careful treading; calculate more or less the average length of his cane, and if he wishes exactness, let him weigh a few feet of cane. I advise him to weigh them because those I have weighed might have been smaller or larger than his, and the calculation would not be correct. But after taking this trouble he will be better able to sum up the pounds of sugar he may have lost, and convinced of the merits of trashing or leaving untrashed his canes.

My own opinion is:—Canes should be trashed each and every time the piece can be weeded. Could this be done every week so much the better. I have always found my pet piece has paid me better than any other for the labour, manure, and *irrigation* bestowed on it. The trash should be laid on the banks, and when the canes are covering in the weeds, may be buried in, or left on the distance between the cane shoots in the row or cross bank. Should any cane be lodged a wad of trash ought to be made and

placed under it, to prevent its taking root when lodged. *Green trash should never be torn from the cane.* But once the canes are thick enough and long enough to settle themselves down generally, the less they are touched the better they will yield per acre in sugar. This conviction of mine is the result of a good many years' practice, of course other planters may have equal reason to think otherwise. Doctors differ in opinion! Why should not planters?

Take a single cane shoot, and give it garden cultivation, and by all means strip off each dry leaf the day you see it make an effort to remove itself. I once obtained over seven hundred pounds of cane from one plant, which from only two eyes shot forth forty two sprouts, making canes from fifteen to twenty feet long, weighing, some sixteen and others eighteen ounces per foot. But in fields of canes I have always found it preferable to cultivate highly. Keep the canes free from weeds, remove carefully from about the roots all the useless suckers, and *dry trash, mould* up judiciously, touch no green leaf, but remove all dry ones; do this till the canes cover in thoroughly, and they will afterwards free themselves of trash sufficiently to ripen.

R. E. Burton.

SUGAR STATISTICS—GREAT BRITAIN.

To Nov. 14th, 1874 and 1873. In Thousands of Tons, to the nearest Thousand.

	STOCKS.		IMPORTS.		DELIVERIES.	
	1874.	1873.	1874.	1873.	1874.	1873.
London	77 ..	85	241 ..	230	244 ..	212
Liverpool ..	47 ..	54	148 ..	163	153 ..	139
Bristol	5 ..	2	71 ..	68	73 ..	71
Clyde	27 ..	53	148 ..	183	174 ..	178
Total ..	156	194	608	644	644	600
	Decrease, , 38.		Decrease. . 36.		Increase. . 44	

STOCKS OF SUGAR IN THE CHIEF MARKETS OF THE WORLD ON THE 1ST OCTOBER, FOR THREE YEARS, IN THOUSANDS OF TONS, TO THE NEAREST THOUSAND.

Great Britain.	France.	Holland	Germany (Zollverein)	Six other *entrepôts.*	TOTAL 1874.	TOTAL 1873.	TOTAL 1872.
201	72	39	6	6	324	336	263

CONSUMPTION OF SUGAR IN EUROPE FOR THREE YEARS, ENDING 1ST OCTOBER, IN THOUSANDS OF TONS.

Great Britain.	France.	Holland	Germany (Zollverein)	Six other *entrepôts.*	TOTAL 1874.	TOTAL 1873.	TOTAL 1872.
837	262	32	299	113	1543	1446	1244

ESTIMATED CROP OF BEET ROOT SUGAR ON THE CONTINENT OF EUROPE, FOR THE ENSUING SEASON, COMPARED WITH THAT OF THE THREE PREVIOUS SEASONS.

(From Licht's Monthly Circular.)

	1874-75. Tons.	1873-74. Tons.	1872-73. Tons.	1871-72. Tons.
France	390,000	396,578	408,649	335,351
Germany (Zollverein)	245,000	288,972	258,663	189,166
Austro-Hungary	140,000	169,250	214,107	161,527
Russia and Poland	130,000	150,000	150,000	90,000
Belgium	65,000	70,366	75,978	72,236
Holland and other Countries	30,000	35,000	35,000	25,000
Total	1,000,000	1,110,166	1,142,397	873,280

STATE AND PROSPECTS OF THE SUGAR MARKET.

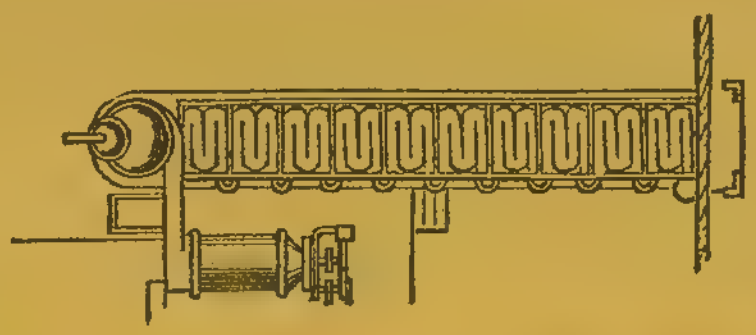
During the past month the sugar market has remained in a very inanimate condition. The sales, both of Raw and Refined, have been very small and the general tone of the trade has been much depressed. In the raw market the low point to which the stock has fallen compared with the same time in 1873 has made the probable future course so uncertain that little decline in price has as yet taken place—holders still clinging to the hopes inspired by the statistics and buyers being little inclined to operate unless at a considerable reduction. The refined market, however, has not been buoyed up by statistical considerations, but has undergone a considerable decline in prices, especially in the higher grades of crystals,—pieces are also considerably reduced in value since the end of October.

Several refineries have already reduced their output and doubtless, if this state of things should continue, others will follow their example. But it is possible that the Christmas demand will again animate the refined market, although at the same time it must be borne in mind that there is a general disinclination to be found with a large stock at the end of the year. In any case a reaction must soon arrive, since a reduced output of refined will be inevitable under the present conditions.

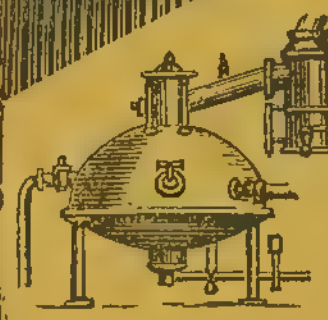
The latest quotations of standard qualities are as follow: No 12 Havana afloat 25s. 6d., against 26s. to 26s. 6d.; fair to good refining Cuba Muscovadoes, 23s. to 23s. 6d., the same as last month; middling to good brown Bahia, 20s. 6d. to 21s. 6d.; also the same as last month. The stock at the four ports is now 156,054 tons, against 171,135 tons at the end of October.

No. 54.

Vol. VI.



THE BOY'S OWN BOOK.





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MAKERS OF THE CONCRETOR.

USE OF THE CONCRETOR FOR MAKING SUGAR.

THE belief appears to be prevalent that the Concretor is only applicable to the manufacture of "concrete" sugar. This is not the case, as it may with equal advantage be used in conjunction with the centrifugal

machine for the production of yellow to fine counter sugars, or in connection with the vacuum pan for making the finest class of vacuum pan sugars.

A few words in reference to each of these methods of using the Concretor.

1ST METHOD.—Use of the Concretor alone to make "concrete" sugar When this is the object to be attained, the manufacturer proceeds as follows:—

The cane is crushed and the juice clarified or defecated in the usual way. After the defecation the juice passes on to the "tray" of the Concretor. Here it is concentrated up to about 30 to 33° Baumé at which density it passes into the "revolving cylinder," also forming a portion of the apparatus. The interior of this cylinder is full of spiral blades of iron. As the cylinder revolves these spiral blades take up the concentrated juice or syrup, and expose a very large surface of it to the action of a current of hot air drawn through the cylinder by a fan, which forms part of the machine. The evaporation in this cylinder is conducted entirely by means of hot air, the consequence being that though the evaporation proceeds rapidly, the temperature of the juice or syrup is kept low; indeed, on entering the cylinder the temperature of the syrup at once falls to about the temperature at which it would be boiled in a vacuum pan.

In this cylinder the syrup is concentrated to such a point that on being discharged from it and allowed to cool, it becomes quite hard, and is *at once* ready for sale or shipment to any distance.

In working the Concretor in this way *no molasses whatever* is made, but for every gallon of juice at 10½° Baumé supplied to the apparatus, it yields two pounds of raw sugar (or "concrete,") of a quality varying according to the quality of the cane-juice from which it was made.

The advantages of this method of using the Concretor, are:—

1.—The *smallness of the outlay* required for the manufacture of a given quantity of cane.
2.—*Economy in labour.*
3.—*Largely increased quantity of sugar* from a given quantity of juice.
4.—Abolition of distillery, charcoal filters, centrifugal machine, molasses, tanks, &c.

Its disadvantage is, that though very much more sugar is obtained by this process from a given quantity of cane juice than by any other system of manufacture whatever, yet this sugar does not realise so high a price per ton as vacuum pan sugar.

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1st Method.—Use of the Concretor alone to make "concrete" sugar When this is the object to be attained, the manufacturer proceeds as follows:—

The cane is crushed and the juice clarified or defecated in the usual way. After the defecation the juice passes on to the "tray" of the Concretor. Here it is concentrated up to about 30 to 33° Baumé at which density it passes into the "revolving cylinder," also forming a portion of the apparatus. The interior of this cylinder is full of spiral blades of iron. As the cylinder revolves these spiral blades take up the concentrated juice or syrup, and expose a very large surface of it to the action of a current of hot air drawn through the cylinder by a fan, which forms part of the machine. The evaporation in this cylinder is conducted entirely by means of hot air, the consequence being that though the evaporation proceeds rapidly, the temperature of the juice or syrup is kept low; indeed, on entering the cylinder the temperature of the syrup at once falls to about the temperature at which it would be boiled in a vacuum pan.

In this cylinder the syrup is concentrated to such a point that on being discharged from it and allowed to cool, it becomes quite hard, and is *at once* ready for sale or shipment to any distance.

In working the Concretor in this way *no molasses whatever* is made, but for every gallon of juice at 10½° Baumé supplied to the apparatus, it yields two pounds of raw sugar (or "concrete,") of a quality varying according to the quality of the cane-juice from which it was made.

The advantages of this method of using the Concretor, are:—

1.—The *smallness of the outlay* required for the manufacture of a given quantity of cane.

2.—*Economy in labour.*

3.—*Largely increased quantity of sugar* from a given quantity of juice.

4.—Abolition of distillery, charcoal filters, centrifugal machine, molasses, tanks, &c.

Its disadvantage is, that though very much more sugar is obtained by this process from a given quantity of cane juice than by any other system of manufacture whatever, yet this sugar does not realise so high a price per ton as vacuum pan sugar.

It is for the planter to decide, multiplying the quantity of sugar produced by the price he can obtain for it, and taking into account reduced interest on capital, in consequence of the comparative cheapness of the machinery needed for making "concrete" sugar, and also reduced costs of manufacture, through economy in labour and fuel, whether it might not pay him better to make the larger quantity of low priced sugar, rather than the smaller quantity of high priced sugar.

The inventor and the manufacturers of the Concretor believe, that unless there be a demand for counter or vacuum pan sugar for local consumption or other exceptional circumstances, it will pay the planter better to make the large quantity of "concrete" sugar, rather than the smaller quantity of higher priced sugar.

2nd Method.—Use of the Concretor in conjunction with the centrifugal machine, to make counter sugars.

The process of concentration is conducted much in the same way as in No. 1 method, except that the syrup as it leaves the Concretor "trays," ought either to be filtered through bag filters, or allowed to subside for 24 hours before it passes to the cylinder. The object of this filtration is to remove any mechanical impurities left in the juice, which if not removed would be likely to impart an objectionable gray tinge to the sugar.

Charcoal filters might be employed at this stage of the process, if the whiteness of the sugar were thought to be more important than the cost of its production.

In the revolving cylinder the syrup is not concentrated to quite so high a point as if "concrete" sugar were to be made. From the cylinder the syrup is passed into coolers where it is allowed to stand for 24 hours to crystallize; after this it is drained in the centrifugal machine.

The molasses obtained from the "first sugar" may be boiled down a second time in the revolving cylinder to produce "second sugar."

The disadvantages of this system as compared with No. 1 method of working, are—

1.—Increased outlay for machinery, since centrifugal machines, filters and molasses tanks are needed.

2.—Increased cost of production, for as there are more processes to be gone through, so more labour and more fuel are required than where "concrete" sugar is produced.

3.—Diminished quantity of sugar obtained.

The advantage of the process is that it produces a nice looking sugar, pure, and of good colour, which will sell at a higher price per ton than concrete sugar.

3rd Method.—Use of the Concretor as an auxiliary to vacuum pan.

Where the Concretor is thus employed it occupies the place usually filled by the "triple effet" where that system is used in concentrating the juice for the vacuum pan. The Concretor performs this work of preparatory concentration for the vacuum pan more rapidly and more economically than the "triple effet." It needs no large boilers, nor costly air and water pumps to aid it; it requires no skilled workmen to take charge of it; it does not readily get out of order and if out of order is very easily put right again.

When used in connection with the vacuum pan, the juice is only concentrated up to about 20° Baumé on the "trays;" it then passes to the revolving cylinder where its density is raised to 30° or 32° Baumé. After leaving the cylinder the concentration of the syrup is completed by the vacuum pan in the usual way.

The advantages and disadvantages of this method of working are similar to those of No. 2 method but more marked, since No. 3 system needs still more machinery and more labour and fuel, though at the same time it yields a more beautiful and higher priced sugar than No. 2 method.

The time occupied by the juice in traversing the "trays" is only about 10 minutes, during which time the juice is concentrated from say 10° up to 30° or 32° Baumé.

In the revolving cylinder it remains for about 20 minutes, during which time the evaporation is completed. The sugar leaves the cylinder in such a state that as it cools it becomes a solid mass not liable to drainage.

Thus the juice is only exposed to heat *for about half an hour*. On the "trays" where the juice is thinnest and therefore best able to bear heat without injury, the temperature is about 214° to 216° Faht. A thermometer plunged into the juice on the trays *at any point* rarely or never registers more, and even this temperature lasts for only about ten minutes. When the juice passes from the "trays" into the revolving cylinder its temperature *at once* falls to about 160° or 170° Faht. The temperature gradually rises as the syrup approaches the outlet until it becomes 190° or 200° Faht. at the point where the sugar issues from the cylinder.

Let these temperatures and the length of time during which the juice is exposed to them be compared with the temperatures of the triple effet and vacuum pan and the length of time during which the juice is exposed to *them*, and it will at once appear that *less* harm is done to the colour and chemical constituency of the juice by the Concretor than by the triple effet and vacuum pan.

If then the planter wishes to make the classes of sugar produced by either of the first two methods of working the Concretor, he will assuredly produce them far more advantageously to himself by using the Concretor than by employing any other method of manufacture whatever.

If on the other hand, he desires to make the finest vacuum pan sugar it will cost less to make this with the Concretor and vacuum pan combined than with the triple effet and vacuum pan combined, while the sugar thus obtained will be *at least* as good as where the triple effet is employed, if not better.

Of the many Concretors sold, some are being used in the manner first described, others are being employed in conjunction with the centrifugal to produce counter sugars, and others are being worked in the third way mentioned in connection with the vacuum pan.

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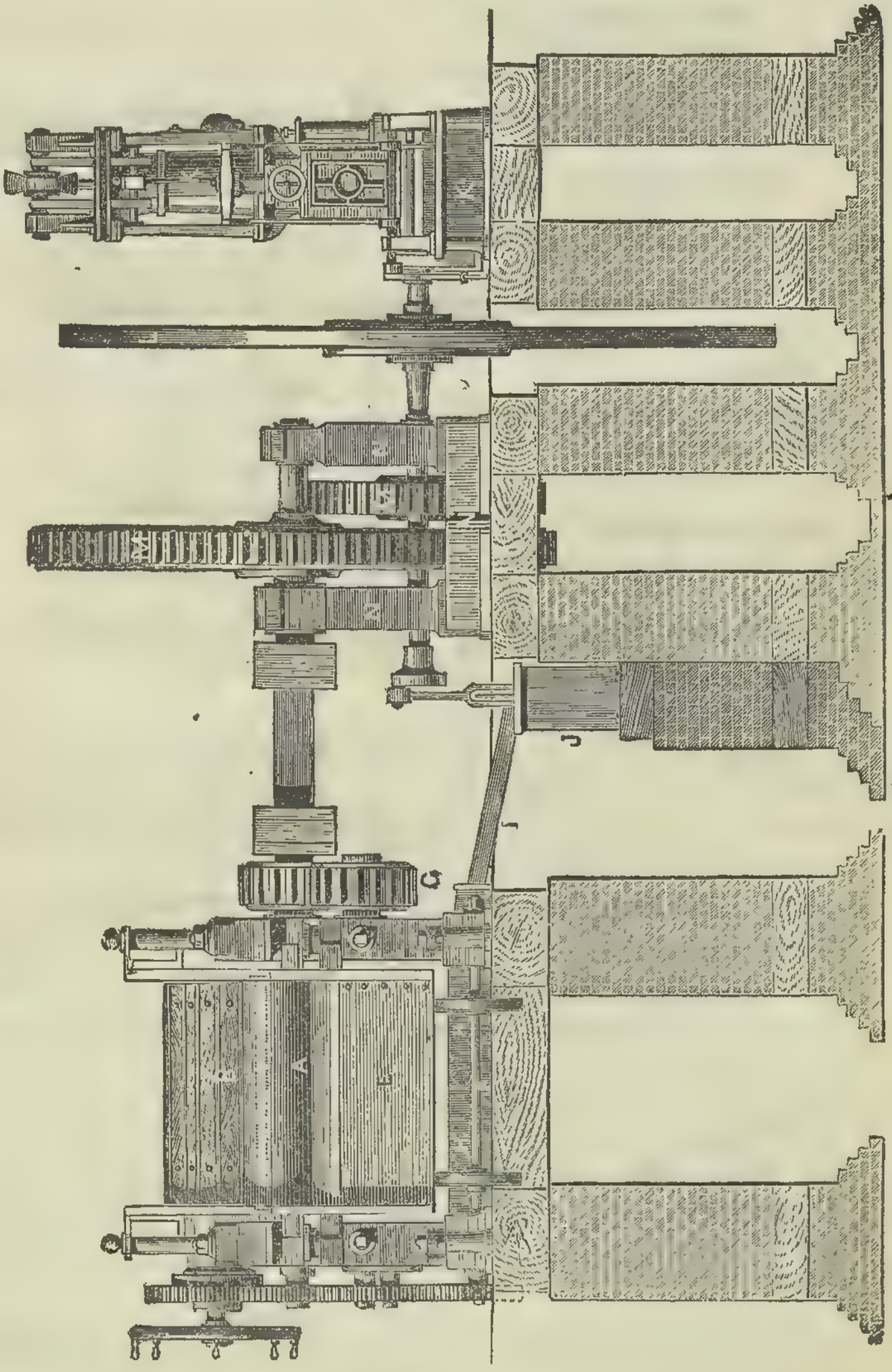
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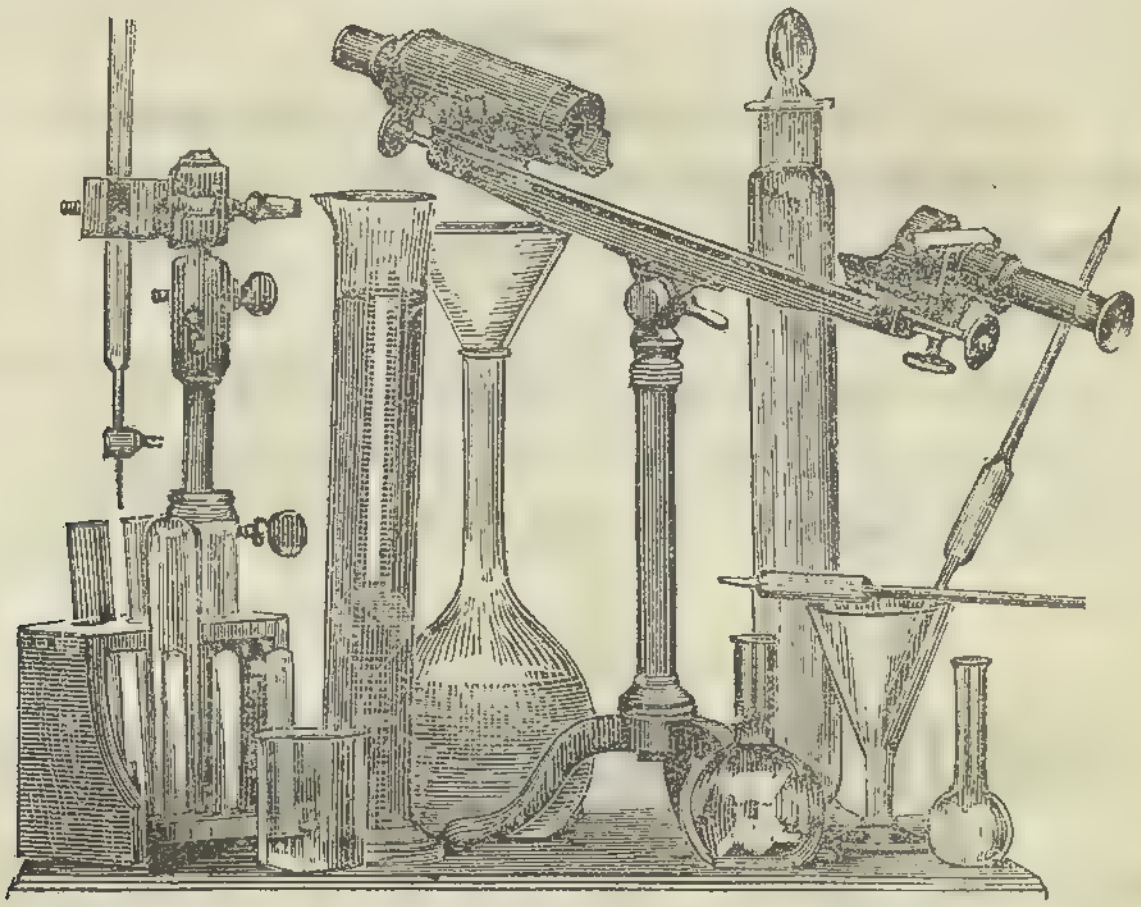
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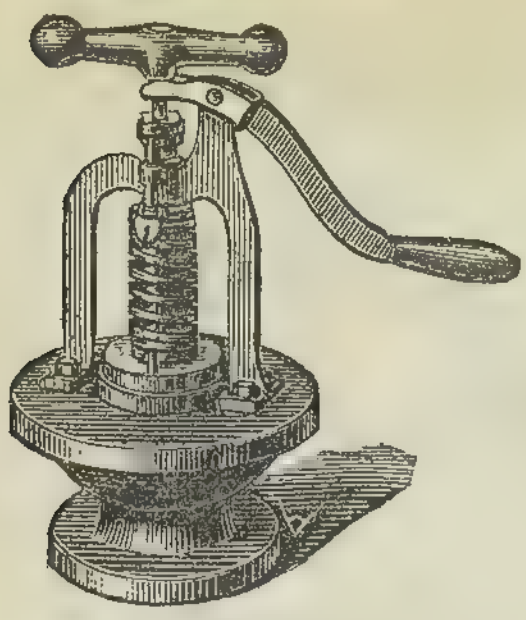
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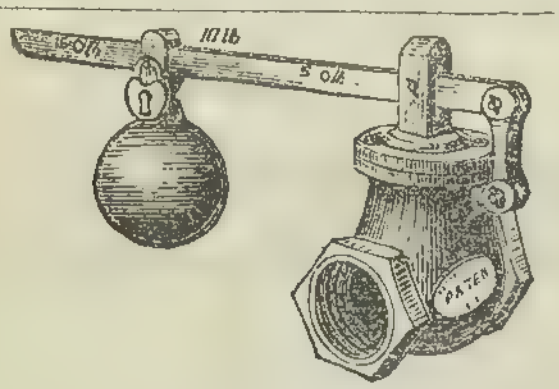


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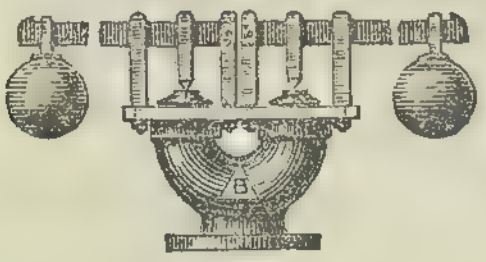


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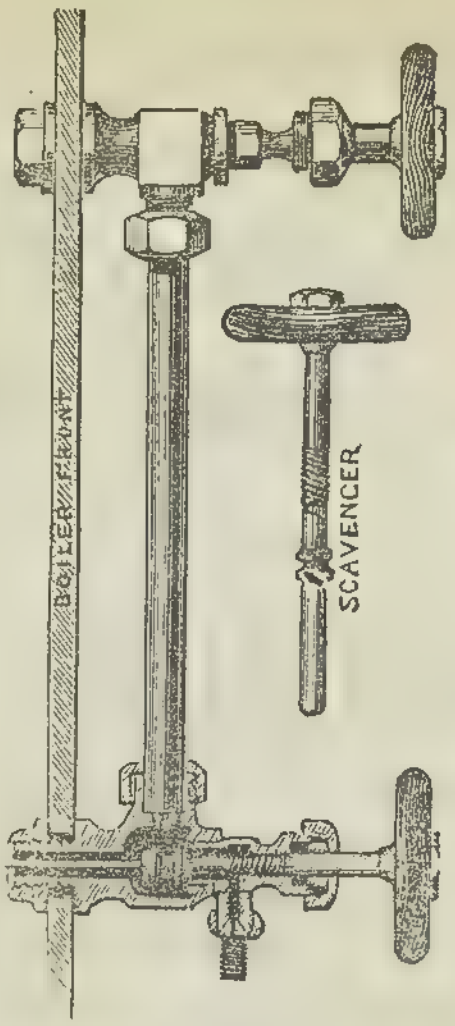
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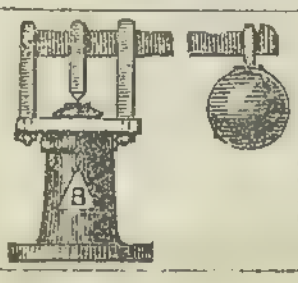
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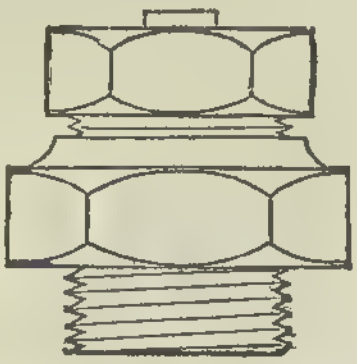
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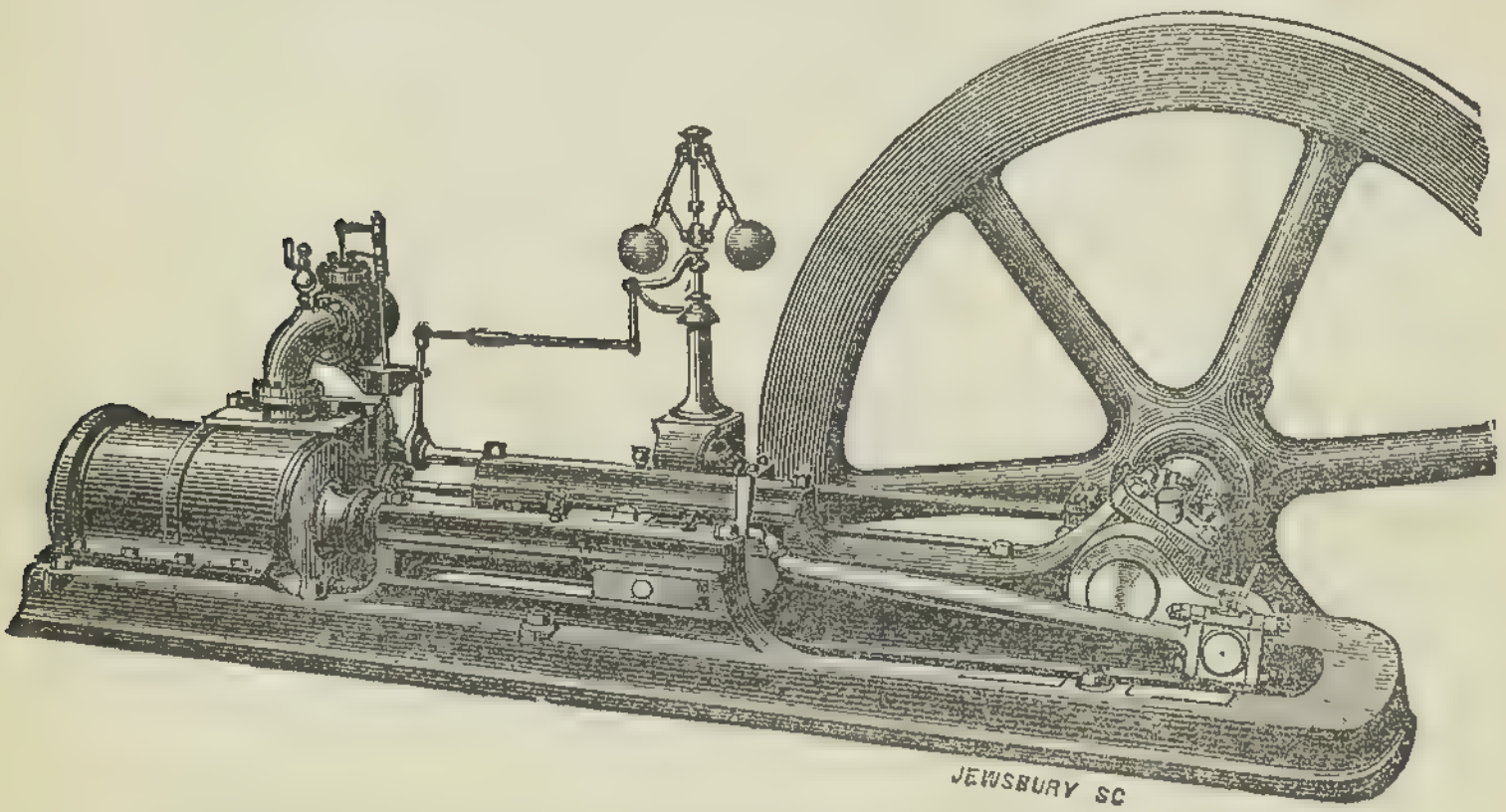
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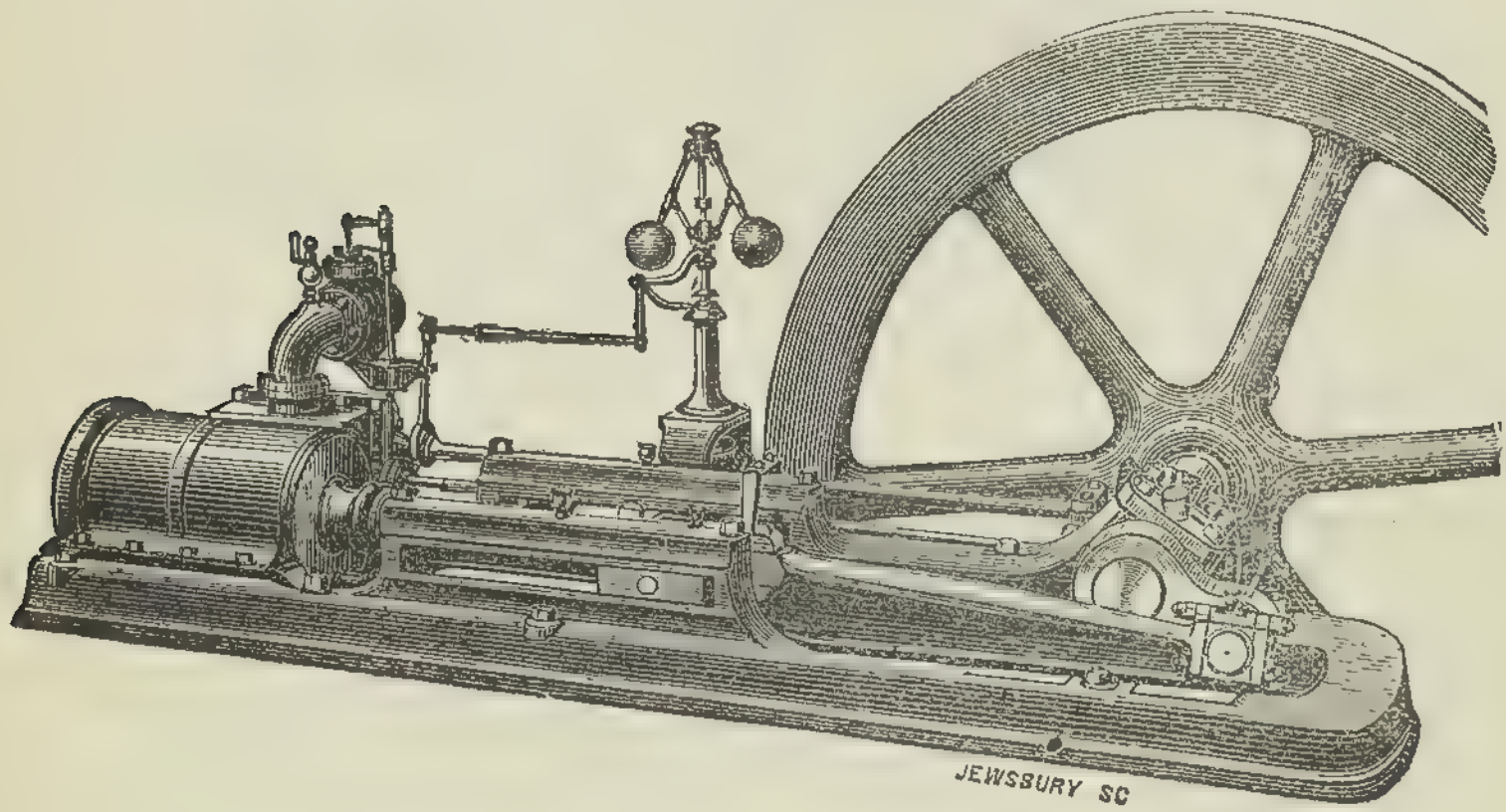
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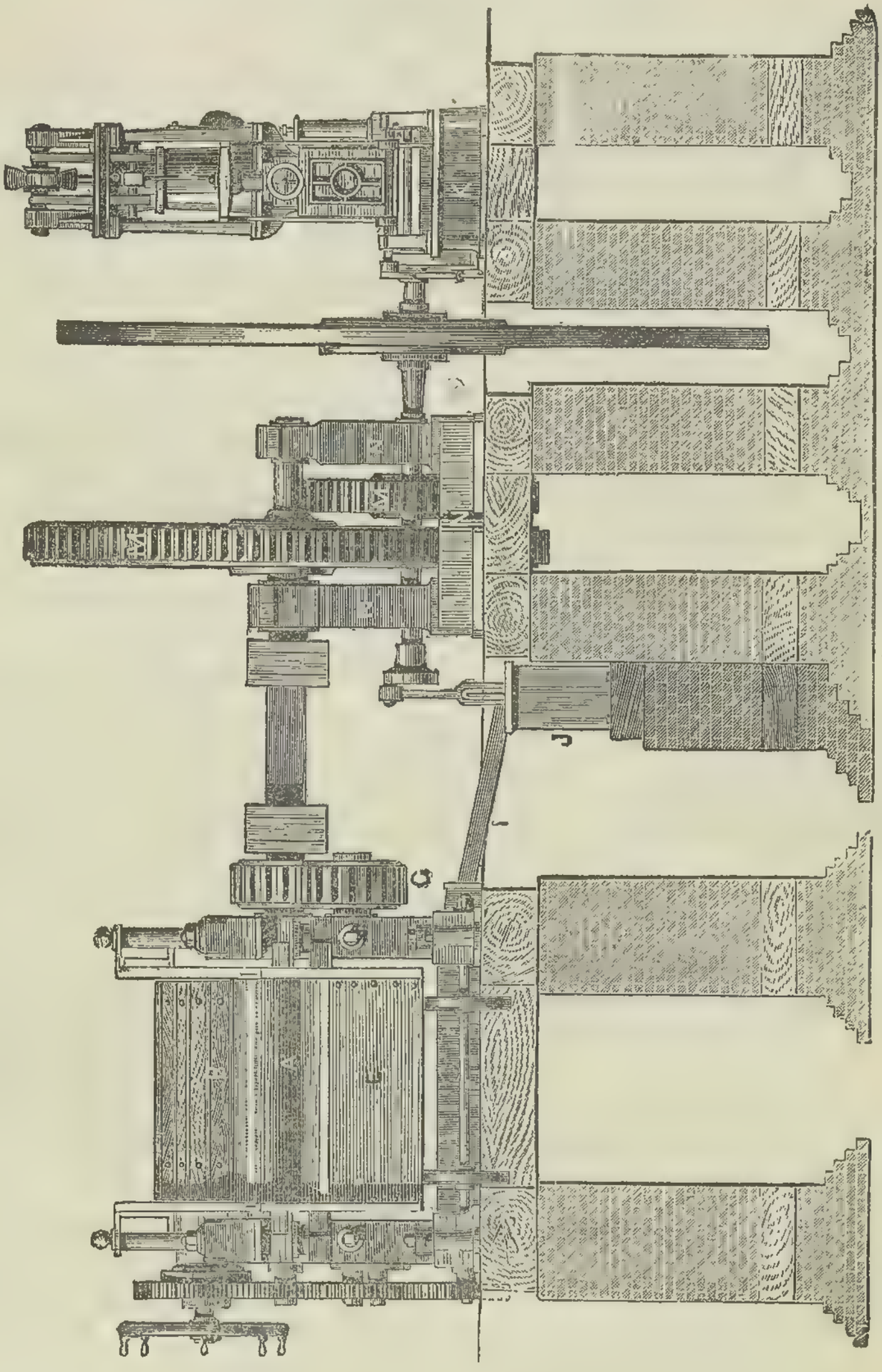
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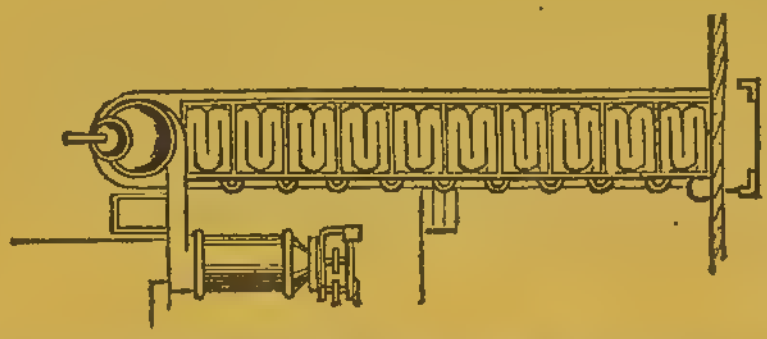
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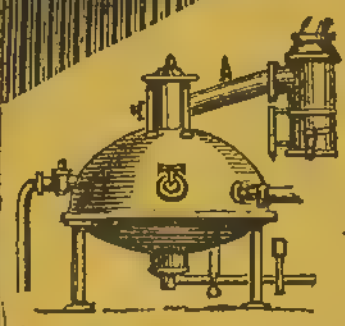
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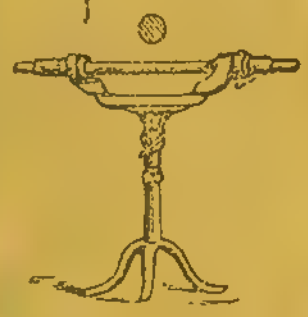
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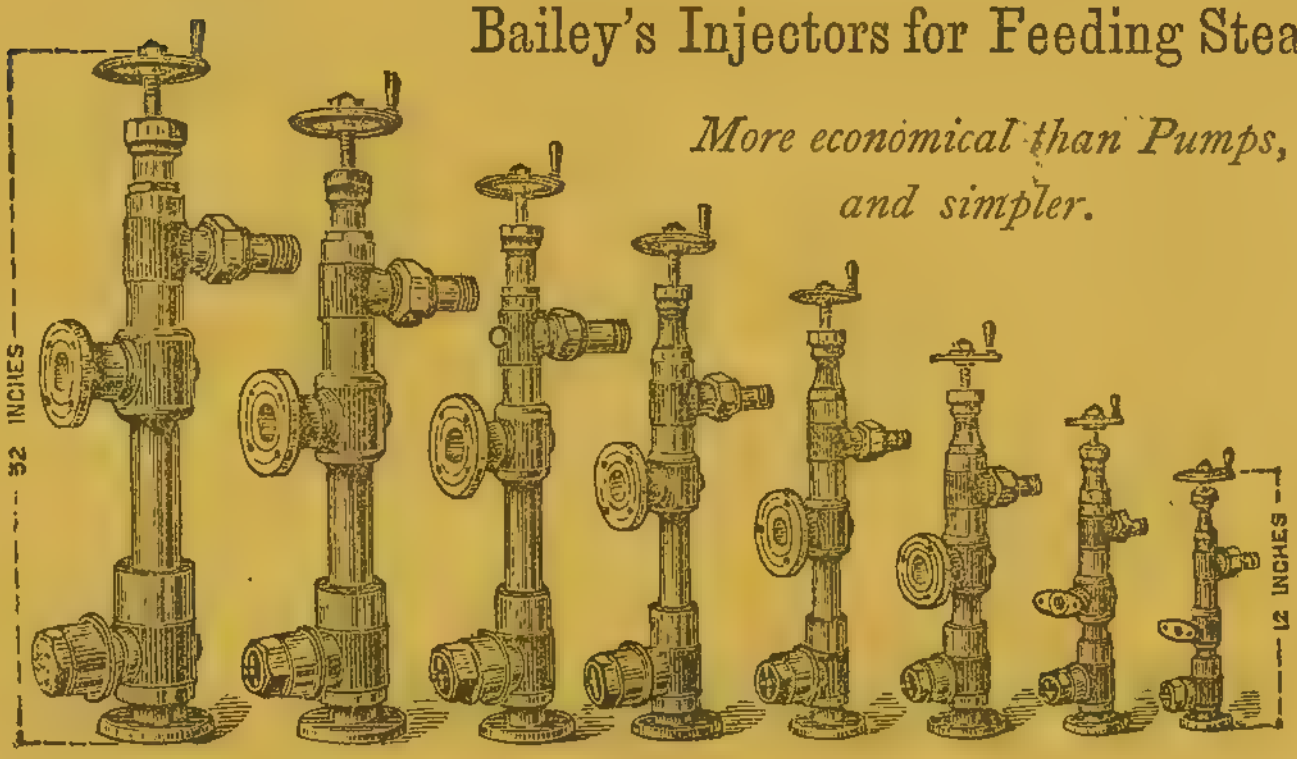
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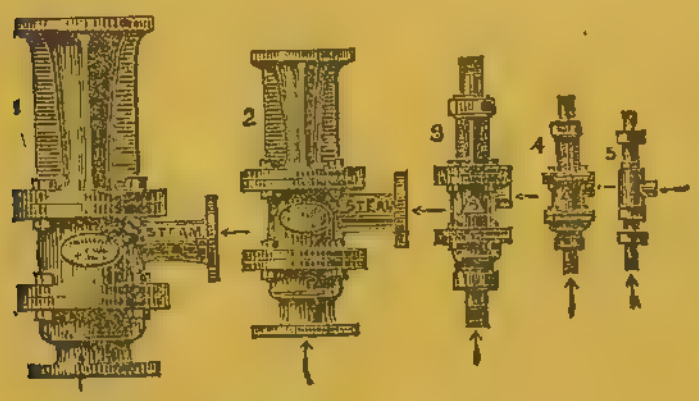
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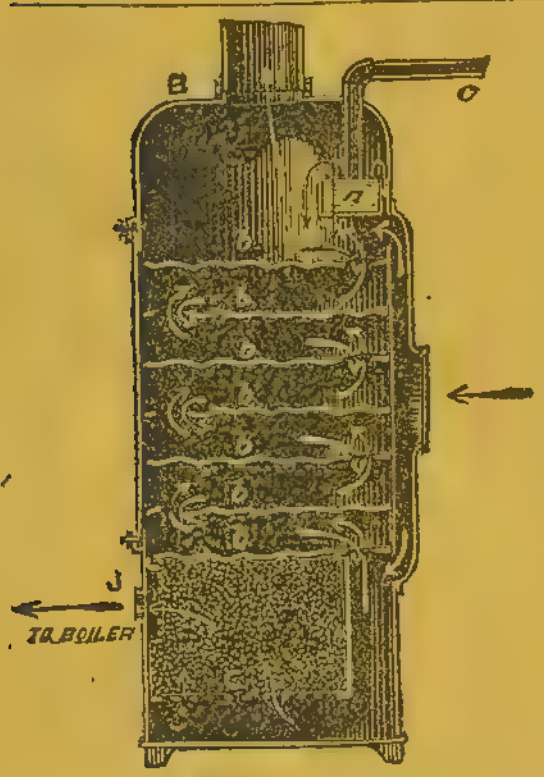


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